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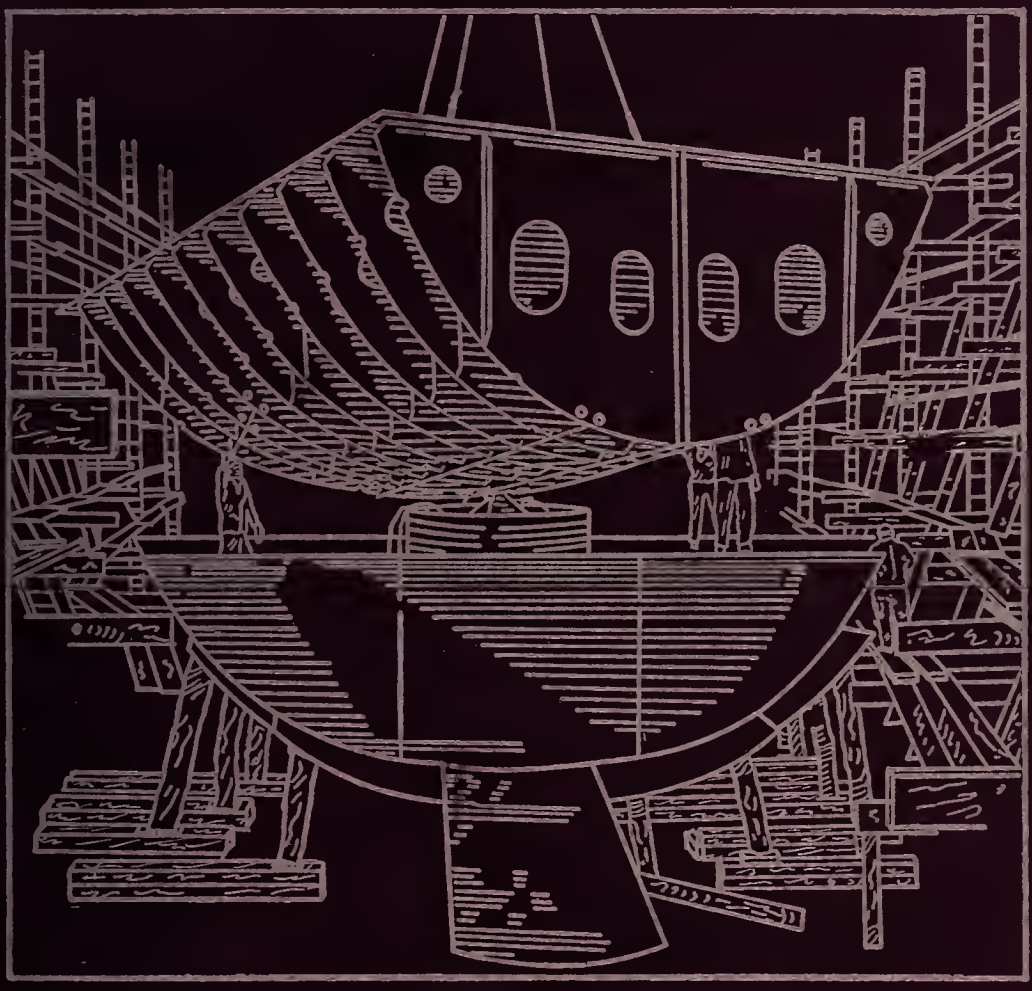
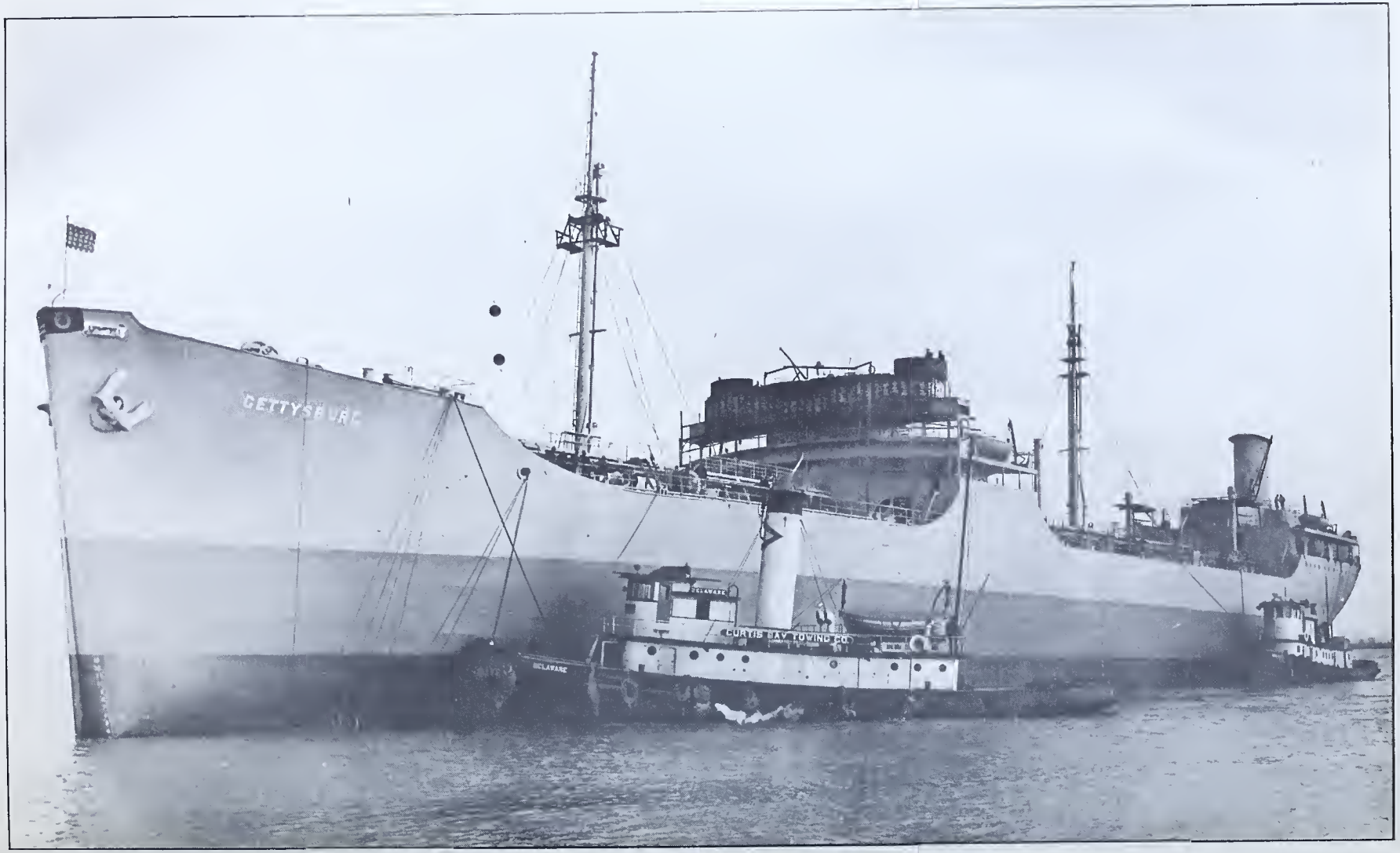
SHIP ERECTION



Prepared by the
DIVISION OF INDUSTRIAL EDUCATION
in cooperation with
SUN SHIPBUILDING AND DRY DOCK COMPANY

BULLETIN 349
Commonwealth of Pennsylvania
DEPARTMENT OF PUBLIC INSTRUCTION
June 1942

Vocational Education
for
National Defense



Type T2-SE-A1 All-Weld Tanker

SHIP ERECTION

(A Manual of Instruction for Pre-Employment and Supplementary Training)

Bulletin 349

Prepared by the

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC INSTRUCTION
DIVISION OF INDUSTRIAL EDUCATION

In Cooperation With

SUN SHIPBUILDING AND DRY DOCK COMPANY
CHESTER, PENNSYLVANIA

SCHOOL DISTRICT, CITY OF CHESTER
CHESTER, PENNSYLVANIA

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1942

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FOREWORD

The rapid expansion of shipbuilding, with an accompanying increase in the number of ship erectors and ship erector helpers to be trained, has prompted the development and publication of this manual of instruction.

The procedures presented in this manual are specifically those which are followed in the yard of the Sun Shipbuilding and Dry Dock Company. Persons who have developed this material realize that certain procedures may not be applicable to all types of shipyards. However, much of the information presented is standard practice which will be useful in training ship erector helpers and ship erectors for most plants.

Acknowledgment is made to the Sun Shipbuilding and Dry Dock Company, Chester, Pennsylvania, and to foremen, mechanics, and draftsmen, employed by the Sun Yard, for assistance and cooperation in making the preliminary analysis and in preparing instructional materials.

Special acknowledgment is extended to Harry Husum, Ship Erector Assistant Foreman, for materially assisting in the preparation of text matter, sketches, and photographs, and also for serving in the capacity of a technical adviser. The assistance of foremen and mechanics in criticizing final copy is acknowledged.

Appreciation is extended to William A. Brock, Coordinator of Industrial Education, to Chester School District, and to D. Francis Hallowell, Coordinator of Chester Area Defense Training Program, for assistance in this work.

This manual of instruction was prepared by the Chester Field Curriculum Laboratory of the Pennsylvania Department of Public Instruction, under the direction of Charles F. Zinn, Adviser, Division of Industrial Education, with the assistance of George M. Schaffer, Adviser, Division of Industrial Education.

This unit was completed under the general supervision of Paul L. Cressman, Director, Bureau of Instruction, and Urwin Rowntree, Chief, Division of Industrial Education.

FRANCIS B. HAAS,
Superintendent of Public Instruction

June, 1942

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Part I

LOCATION OF UNITS OF A SHIP

In that the ship erector primarily is concerned with the placing of ship hull assemblies in their predetermined positions, it is important that the ship erector trainee learn to know hull assembly locations, and be capable of determining these locations from blueprints.

Shipbuilding terms and definitions appear in Appendix II — Glossary.

The shell plating of a ship is its outside surface or covering from, and including, the flat keel outward and up the side to the level of the deck; also from end to end of the ship. This shell plating forms the ship's water-tight covering which allows it to float.

Bulkheads give the ship contour, shape, rigidity and strength. They serve to separate the tanks and divide the ship into separate tanks or water-tight compartments. These bulkheads are defined as transverse center tank bulkheads, transverse wing tank bulkheads, and longitudinal bulkheads. All transverse bulkheads extend athwartship while all longitudinal bulkheads extend lengthwise of the ship. In Fig. 2, the deck plan view of a tanker, we find the bulkheads marked by the dashed lines, and the transverse are easily distinguished from the longitudinal. The cargo tanks are numbered from No. 1 to No. 9 in numerical order beginning at the forward cofferdam, Fig. 1, and proceeding aft to the after cofferdam. Each of these cross-section tanks is divided into three parts: one wing tank port side, one center cargo tank, and one wing tank starboard side; forming in all a total of twenty-seven cargo carrying tanks, each separated from the other by a water-tight or oil-tight bulkhead.

The *forward and after cofferdam* are placed between the oil (inflammable) cargo and the dry compartments to form an air seal, or safety compartment, between the different parts of the ship.

The *pump rooms* (one or more) are the compartments where the pumping machinery, which puts on or takes off cargo at the different ports, is confined.

Fuel oil tanks, one forward and one aft, are used for the ship's supply of fuel oil.

The *dry cargo space* is used for cargo or supplies that are not in a liquid form.

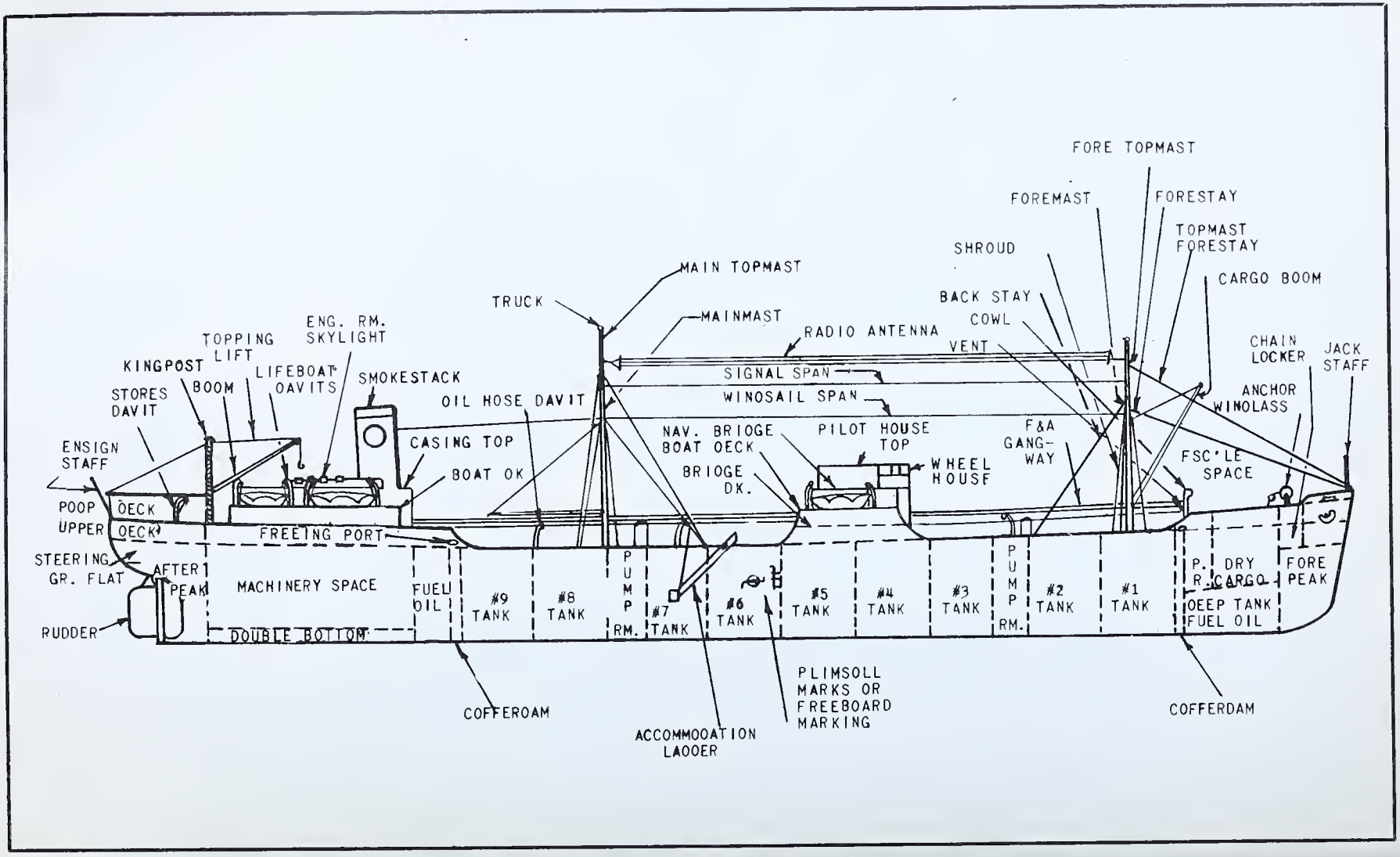


FIG. 1 — *Profile of a Tanker* (*Also, see Frontispiece*)

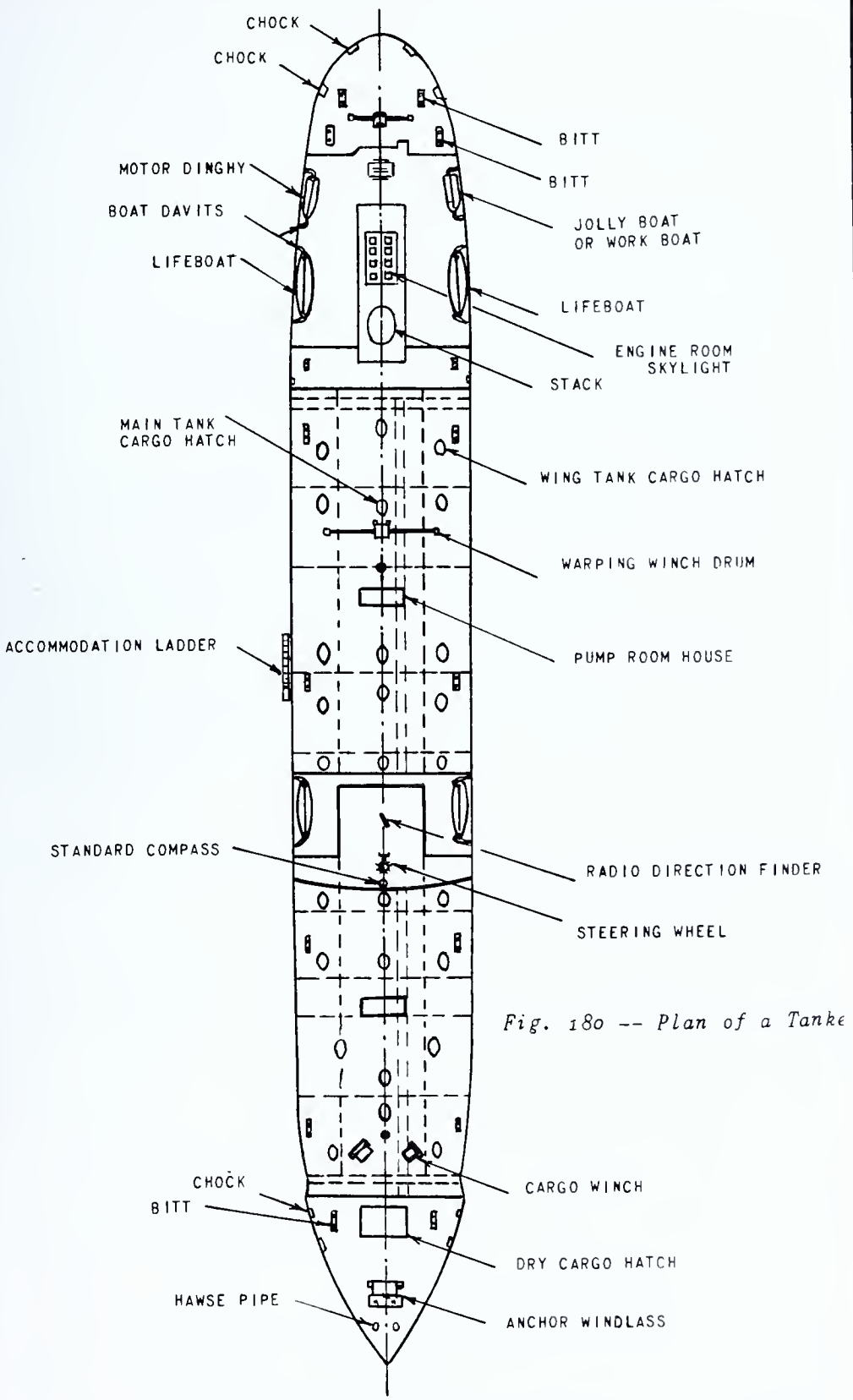


Fig. 180 -- Plan of a Tanke

FIG. 2 — *Deck Plan View of a Tanker*

The *chain locker*, just above the forepeak, is used for storage of anchor chain.

The *forepeak* is a dry buoyancy space, except when used as a ballast tank to level ship.

The *upper deck* is the main deck on a tanker, and extends from one end of the ship to the other as indicated on Fig. 1. It is called the upper deck, main deck, or shelter deck.

The *forecastle deck* is immediately above the upper deck at the forward end. The *bridge deck* is immediately above the upper deck amidship. See Fig. 1. The *boat deck* is above the bridge deck and is so called because the life boat stations are placed here.

Above the boat deck is the *navigation bridge or wheel house*. The top of the wheel house is known as the *house top*.

The *inner bottom*, or *tank top*, forms a large level space with heavy, strong construction which is used as a base for machinery. This double bottom space is used for storage of fresh water and, in some cases, for fuel oil tanks. It also is a safety measure in case of damage to the bottom of the ship.

The *machinery space* is used for propulsion machinery as well as auxiliary lighting, generators, pumps, condensers, and all the other equipment necessary to operate a ship.

The *afterpeak* is used as a dry buoyancy space or as a ballast tank. Immediately above the afterpeak is the steering gear flat where the steering machinery for the ship is located.

Between the upper deck and the *poop deck*, which is just above the upper deck at the after end of the ship, is the *poop house*, or quarters where the crew's cabins are located. There is an *after boat deck* which is above the poop deck, and here, also, the life boats are stationed.

The *rudder* is at the stern of the ship just below the steering gear; it is used to steer the ship.

The plimsoll marks, or freeboard markings, designate the loaded water lines for different water and weather conditions, and are subject to regulations of insurance companies.

The *deck fittings* and *rigging*, such as smoke stack, life boats, booms, davits, accommodation ladder, ensign staff, mainmast, topmast, forward masts, anchor windlass and anchor are not assembled by the erectors. However, their locations can easily be noted by referring to Fig. 1 and a description will be found in the Appendix.

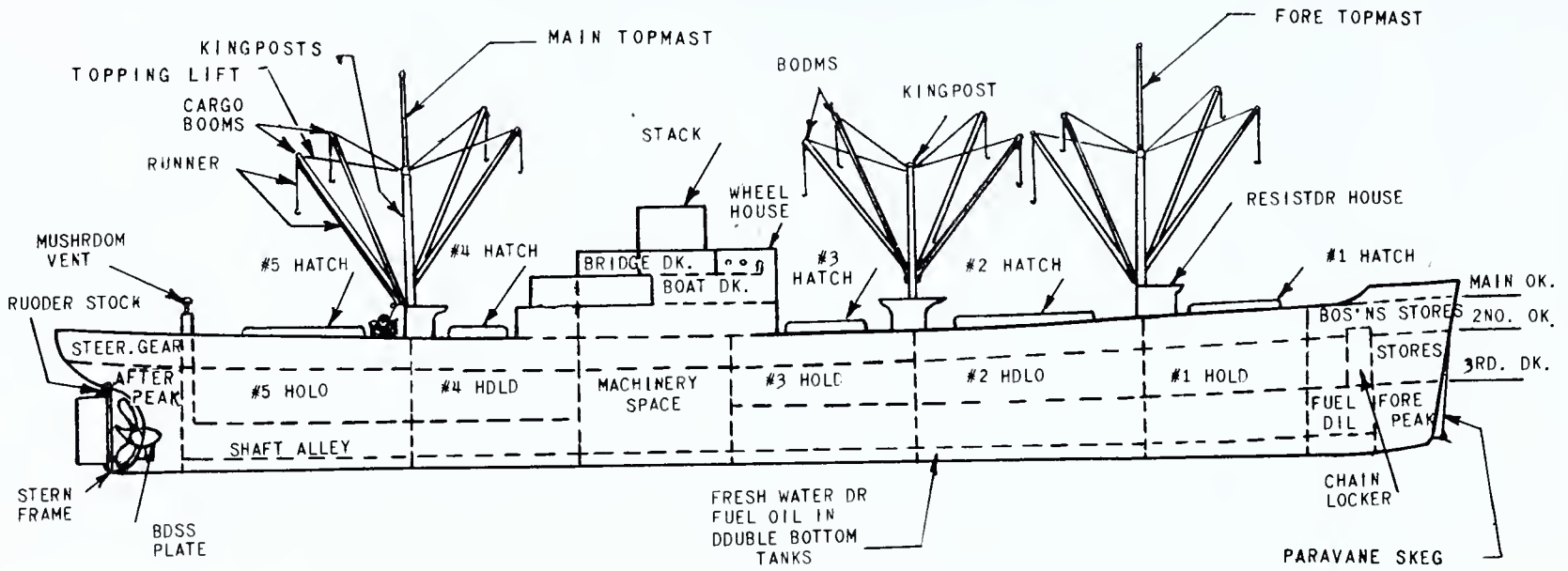


FIG. 3 — *Profile of a Cargo Ship*

Fig. 3 shows the *profile* of a cargo ship, which, when compared to th tanker, differs considerably. The double bottom extends from the afterpeal bulkhead to the forepeak bulkhead. This space, which is under the tank top is used for fresh water or fuel oil, or both.

In the cargo ship shown, the machinery space is located amidship, so tha when the ship is traveling light, balance can be maintained in the fore an aft direction. The machinery space on a tanker is not located amidship be cause this would necessitate the use of a shaft alley through the oil-carryin cargo tanks. On the cargo ship the shaft alley does extend from the engin room through No. 4 and No. 5 holds to the stern frame and propeller.

Most cargo ships have but five cargo holds, each separated from the othe by a water-tight bulkhead. These holds are not separated or divided by an longitudinal bulkheads, although they are separated by different decks, a shown in Fig. 3, the second deck just below the main deck and the third dec below the second. All of these decks are reached through the one hatch a the main deck and are used to separate and keep apart different types o cargo.

On the cargo ship the cabins, or quarters, are usually confined to the amid ship houses, as shown in Fig. 3.

QUESTIONS

1. **How many cargo tanks are in the usual tanker?**
2. **Why is the tanker divided into so many separate compartments?**
3. **Where is the forepeak of a ship?**
4. **What is the upper deck?**
5. **Where is the engine room situated on a tanker?**
6. **Why is the engine room amidship on a freighter?**
7. **In what way do the cargo holds of a freighter differ from those of a tanker?**
8. **Of what use is the double bottom?**
9. **Where is the forecastle?**
10. **Where is the boat deck?**

Part II

SAFE PRACTICES IN SHIP ERECTION

Safety is a vital factor in the conduct of any shipbuilding industry; safe practices should be enforced by the yard and very carefully observed by the men. Both parties are equally concerned. An injury resulting in loss of time is alike disastrous to employer and employee. Protect your ability to earn a livelihood by being safety-conscious at all times. You may protect others as well as yourself through intelligent observation of safe practices. Unsafe practices in a shipyard usually endanger others. Be careful for your fellow workmen as well as for yourself.

Typical Shipyard Hazards

DANGER OF FALLING

- Unsafe footing
- Presence of objects which would make footing hazardous, such as scrap or oil
- Insecure staging, spawls, or other working supports
- Improper treatment of guard rails — improper use of tools
- Improper shoes
- Hose, burning and welding lines, electric feed wires
- Failure to replace staging which has been moved

DANGER FROM FALLING OBJECTS

- Exceeding safe working loads of equipment which may result in breakage
- Insecure fastening of loads
- Poorly applied or unsafe lifting pads
- Leaving loose objects where they may slide off the vessel or staging
- Leaving tools in precarious positions
- Danger of dropping tools while using them
- Danger of dislocating planks, small parts, or other objects in swinging a load with a crane
- Carelessly throwing scrap from the ship
- Improper shoring
- Working under loads being lifted or erected

DANGER FROM INADEQUATE PERSONAL PROTECTION

- Loose clothing, especially pants legs
- Lack of safety shoes
- Lack of safety helmets
- Lack of goggles where necessary
- Lack of proper eye shields around welding
- Taking foolhardy risks
- Improper use of tools and equipment
- Day dreaming

Other Safety Practices

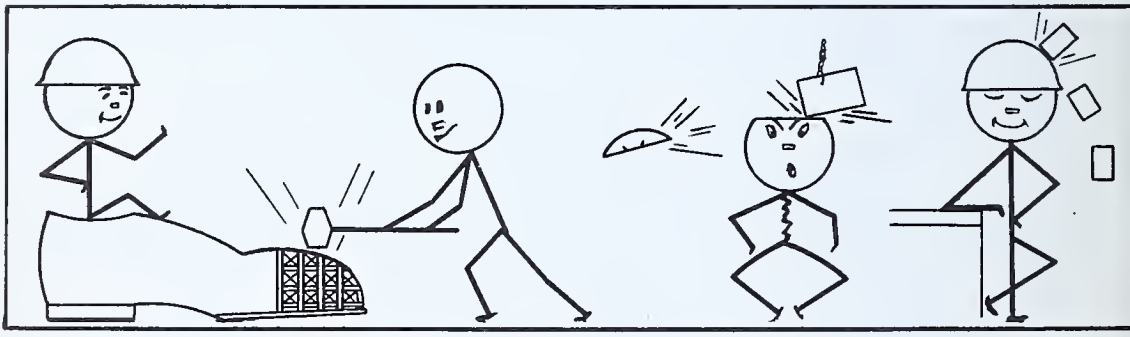
Guarding against combustibles — inflammable materials near welders or burners; also, inadequate ventilation in closed spaces when welding or burning and detecting leaky gas hoses.

Types of Safety

Safety means more than merely "being careful." In that the shipyard worker is largely dependent upon the careful and conscientious adherence to safety provisions on the part of workmen who may have preceded him on a job, it behooves every workman to consider not only his personal safety at the time of doing a piece of work, but also any possible effect which the work he is doing may have upon the safety of those who must work after him, under him, or those who must climb over structures, the security of which may be his responsibility.

Wear Safety Hat and Safety Shoes

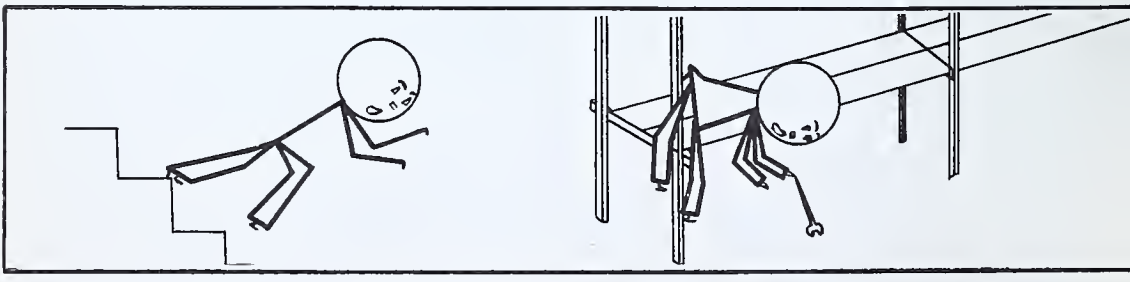
A ship erector should wear a safety hat and safety shoes at all times. Safety belts for unusual conditions should be at hand and used when the work being done requires this added support. These items may be obtained from the safety store of the company.



WEAR SAFETY SHOES AND HELMETS

Avoid Loose-fitting Clothing

In that an erector must do much climbing where loose clothing may catch on protruding objects, it is necessary that special precautions be taken to

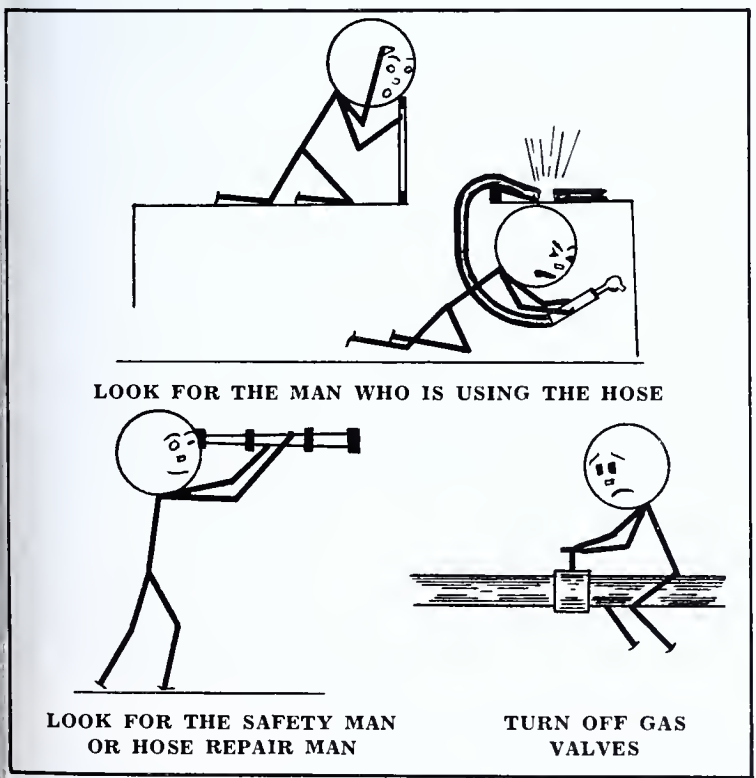


DON'T WEAR LOOSE CLOTHING

avoid any clothing which may be a potential hazard. Loose pants legs are especially dangerous; tie these at the bottom before climbing. Loose sweaters, etc., are to be avoided.

Avoid Damaging Hose Lines

Not all hazards in handling assemblies result from objects striking workmen; the cutting or breaking of welders' or burners' hose lines may be just as dangerous as being struck by a steel plate. Propane and acetylene are highly explosive when mixed with the correct amount of air. In addition, both of these gases burn freely when ignited. If an oxygen hose should be damaged at the same time that a break has occurred in an acetylene or propane hose line, the resulting explosion which may take place will be even more violent. In that most of these gases are heavier than air, any escaping gas tends to collect in the lower enclosed portions of the vessel. To ignite escaping gas it is not necessary for the spark or flame to be near the damaged line; a welder's arc or a burner's flame at a considerable distance may ignite a low-lying blanket of gas. The flame will follow this combustible line of gas back to its source.



Gases, when mixed with air or oxygen, are especially dangerous when confined. In that the heavier gases tend to accumulate or "flow" to the lowest part of the vessel, a workman in the double bottom or any enclosed space may be subject to approximately the same danger which would be present if he were locked in a powder magazine. One spark, or a lighted match, would be followed by a violent explosion.

To avoid damaging hose lines, block all materials securely so as to provide safe clearance for these lines.

Identifying Hose Lines

The *gas hose* used for rivet heaters' pots is made of smooth black rubbe it is about $1\frac{1}{4}''$ in diameter. The *oxygen hose* is about the same size as th heaters' hose, but is about $\frac{5}{8}''$ in diameter. It is used in pairs of red an black, the red hose carrying the propane or acetylene gas. The gas used b burners and welders, and by the rivet heaters, is a highly explosive gas calle "propane." When pure, this gas burns; when mixed with the right amount o air it becomes highly explosive. It is especially dangerous because it is hea ier than air and drops towards the ground instead of rising and dissipatin in the air like other gases. Some yards use acetylene for burning.

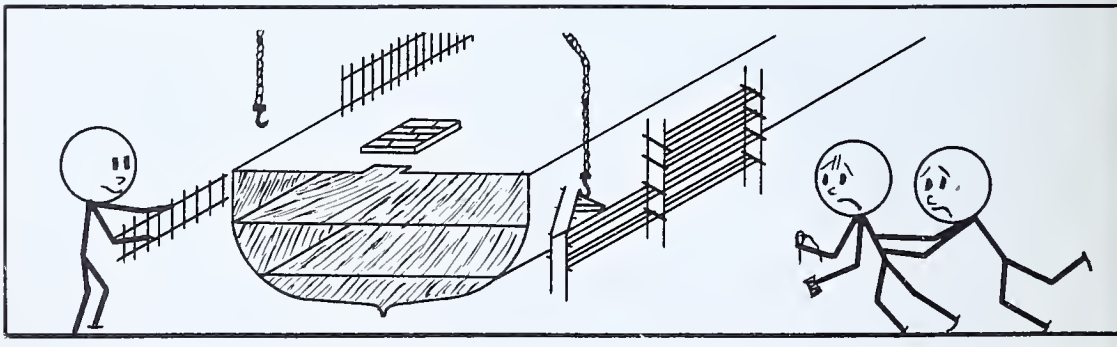
Report All Hose Leaks

Every time a hose is damaged production is retarded. The first concer is to protect workmen by warning them of the danger and shutting off th valves. So that unnecessary time may not be lost, the hose repairman shoul be notified at once.

Danger in Handling Bulkheads

In handling bulkheads or other heavy material, part of the staging ma be damaged. When this happens, be sure that all loose parts are taken dow at once. Notify the safety man or staging foreman so that the damage ma be repaired without delay.

If guard rails are removed in order to facilitate the placing of materi on the ship, the safety man must be informed, or the parts removed must b replaced by the erectors who removed them.

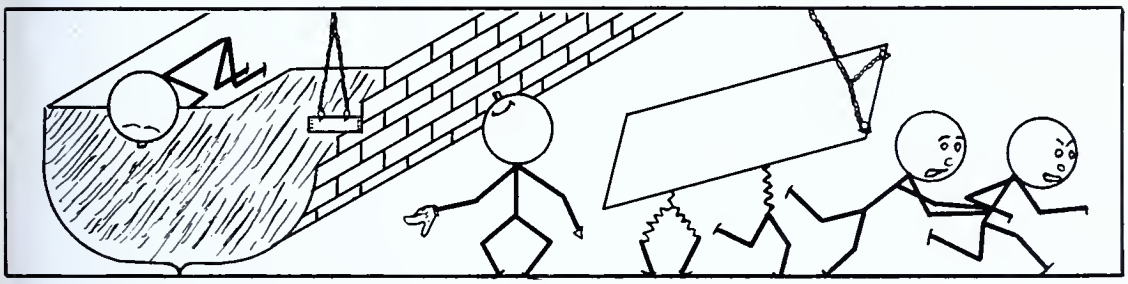


REPLACE GUARD RAILS — HAVE DAMAGED STAGING REPAIRED

Stand Clear of Loads

Stand clear of loads at all times. No matter how well a load is fastene there always is a chance that tackle might slip or that a cable or chain migh break.

When lowering shell plates down the side of the ship, look *up* as well as *down;* the crane block may catch on a plank, pulling it over. Also, shackle bolts may catch on a plank or on the edge of another plate, causing the plate to be temporarily retarded. The sudden dropping of a plate may cause stage planks to be dislodged from their supporting spawls.

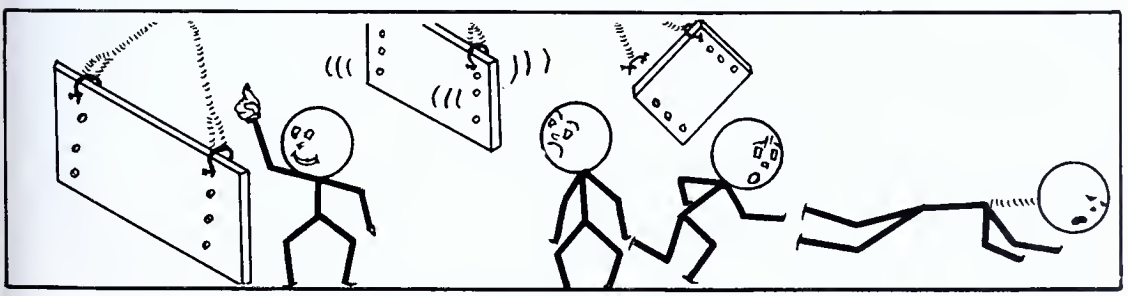


WHEN LOWERING SHELL PLATES LOOK UP AND DOWN — STAND CLEAR OF LOADS WHEN HOISTING OR TURNING OVER

Return Damaged Shackle Bolts

Shackles that are spread should be replaced or repaired. A spread shackle allows the shackle bolt to bend, making it unfit for further use. Shackle bolts are made of special steel which has twice the shear strength of that used in making an ordinary soft steel bolt. Since special shackle bolts are made with rounded heads, they are easily distinguished from common bolts. Always use a special shackle bolt with a shackle. If a new shackle bolt is required return the damaged bolt to the tool room so that it will not be used by another workman. Removing bolts from guard rails for use as shackle bolts is doubly hazardous:

1. These bolts are too soft to be safely used as shackle bolts.
2. The guard rail is left unprotected.



DON'T USE SPREAD SHACKLES

Destroy Faulty Pennants

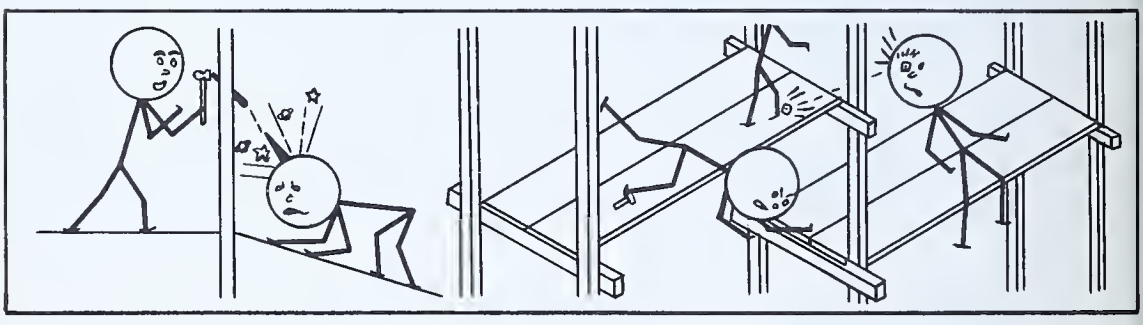
Kinked, frayed, or cut pennants are dangerous to handle and dangerous to use. Such pennants should be destroyed. To obtain new pennants secure an

order from your leader authorizing you to obtain the replacement equipment from the rigging loft. Pennants should be protected by proper use. When lifting a load the slack in a pennant must be taken up slowly and carefully so that an undue strain is not placed on the equipment and so that the pennant does not slip and cause the load to become unbalanced. Handle pennants carefully. Since scratches from frayed pennants may cause serious infections, it is necessary that they be promptly treated at the dispensary.

Avoid Dropping Objects

In handling objects take precautions which will protect from injury persons working near you or under you, by holding a drift pin yourself, or having some person hold it for you, when it is being knocked out of a hole. Avoid dropping nuts, bolts, washers, or other objects. Also, avoid placing objects on staging or other surfaces where it is possible for them to be dislodged by yourself or others. Loose objects are dangerous in two ways:

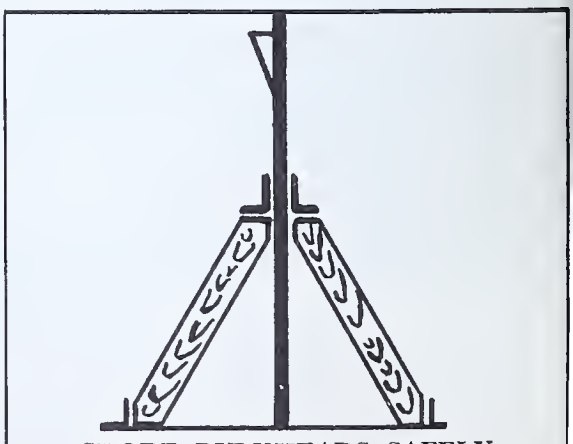
1. They may be dislodged, injuring persons working under the staging.
2. The workman on the staging may trip over loose objects, resulting in a serious fall.



HAVE SOMEONE HOLD DRIFT PINS — DON'T LEAVE NUTS AND BOLTS LYING AROUND

Shore Bulkheads on Both Sides

Bulkheads must be shored on both sides before releasing the crane. Shoring from one side only is an open invitation to disaster. Steamboat ratchets must not be removed from bulkheads or other erections until the leader has determined that such erections are securely fastened and braced.

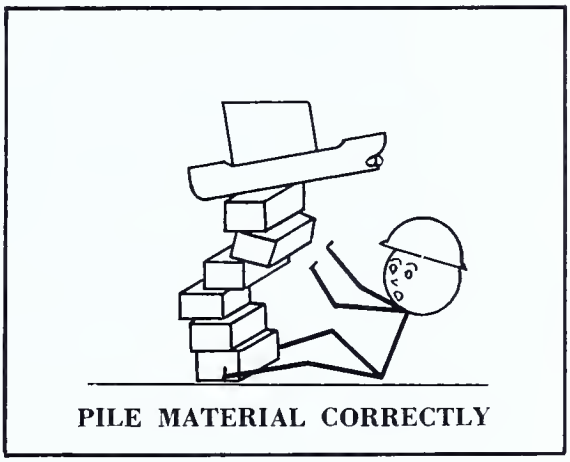


SHORE BULKHEADS SAFELY

Avoid Careless Piling of Material

Pile materials securely and in positions where they are not likely to be jolted or knocked over. Keep piles of materials within safe heights.

Avoid riding the crane hook. If special circumstances should require this practice, permission must first be secured from the leader.



PILE MATERIAL CORRECTLY

Safe practices on each ship are under the supervision of a safety man. Each workman on a ship should learn to know his safety man personally and to recognize him by sight, so that he may be quickly located when needed.

It is the duty of the safety man to encourage and to direct men to work safely, and to provide for the installation of any device which may eliminate hazardous conditions and potential causes of injury aboard ship. In the Sun yard the safety man is easily recognized by the yellow safety helmet which he wears.

By reason of his position, the erector is in charge of cranes. It is the erector's duty to be present and to assist with all stretcher cases when someone has been injured on or around the ship. A wire basket, located at the top deck, is used for removing injured persons by crane from the ship. The first class erector wears a black safety helmet with a white crown.

Safety Suggestions

1. Take no chances.
2. Wear safety helmets where required.
3. Wear goggles wherever needed.
4. Protect your feet with safety shoes.
5. Do not operate machines before receiving instructions.
6. Propane gas, compressed air, acetylene gas, and oxygen are all dangerous. See that you have received proper instructions before using these gases.
7. Horse play is absolutely forbidden.
8. Report to dispensary immediately if injured, even though the injury may be slight.
9. Immediately report hazardous conditions.
10. Observe unwritten as well as written laws of safety.

QUESTIONS

1. When are spawls and planks likely to be dislodged?
2. What types of injuries may result from wearing loose clothing?
3. What precautions should be taken to prevent damaging hose lines?
4. Why are propane or acetylene gas leaks dangerous?
5. To whom should hose leaks be reported?
6. What dangers are likely to result from careless handling of bulkheads?
7. Why are spread shackles dangerous?
8. What are the dangers in handling kinked and frayed pennants?
9. What caution should be observed in removing drift pins?
10. Why should bulkheads be shored from both sides?
11. Why must materials be piled carefully?
12. To whom should unsafe conditions be reported?

Part III
ERECTORS' TOOLS AND THEIR USES

A ship erector has a complete knowledge of the kinds and uses of the tools he needs to erect a ship. Therefore it is part of a learner's job to become acquainted with these tools and how to use them.

A good ship erector always plans his work before actually proceeding to do the job. He will see to it that he has all the tools required to do the job before he actually begins his work.

The following is a descriptive list of the common tools that a ship erector will use:

Belt and Holster

This is a strong leather belt about two inches in width, with a buckle for fastening around the waist, and a holster with a socket in which a spud wrench is inserted and carried. This belt makes it possible for workmen to

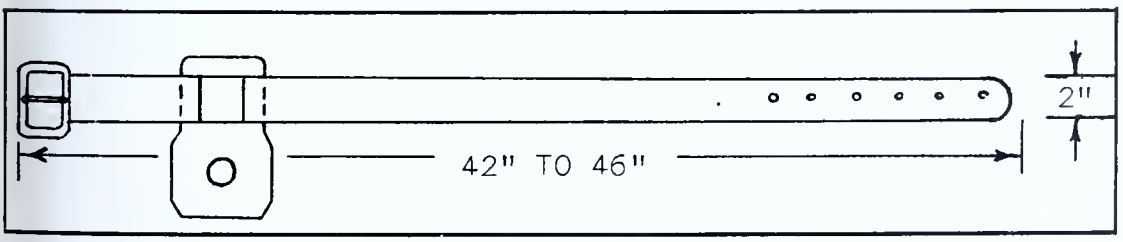


Fig. 4 — *Erector's Belt and Holster*

always have access to the wrench and, at the same time, prevents the latter from being misplaced or from causing injury to those who may be working below the erector, by reason of its being dropped accidentally.

The Spud Wrench

The spud wrench has a good sturdy set of jaws on one end; the other end is long and fairly true to size with a tapered end. This tapered end is used in spudding holes by inserting the tapered end of the wrench into holes in adjacent pieces of steel, thus properly aligning the two pieces of steel for insertion of bolts.

Also, the spud wrench is used as a lever for moving light objects and for tightening and loosing nuts and bolts. When inserted in a rivet hole the wrench can be used as a temporary ladder for climbing. The heavy end may be used as a hammer for light work.

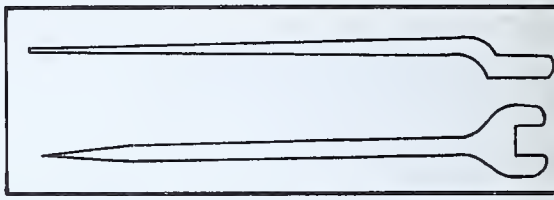


Fig. 5 — *Spud Wrench*

The wrench is available in the following sizes: 3/8", 1/2", 5/8", 3/4", 7/8" and 1". The erector should carry a spud wrench with him at all times, preferably the 3/4" or 7/8" wrench.

The Bar (30" to 36")

The pinch bar, as shown in Fig. 6 is used in moving heavy plates and other objects into place. Being longer, this bar is used where greater pressure must be applied than is possible to obtain with a spud wrench.

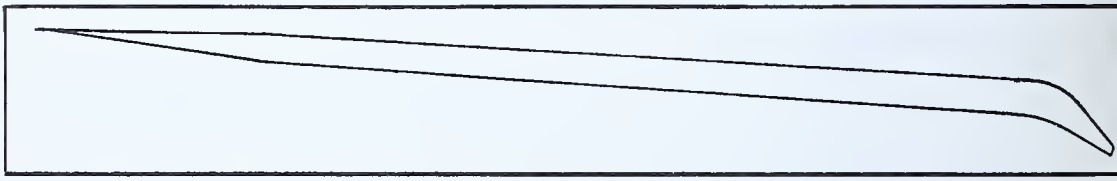


Fig. 6 — *Pinch Bar*

The heel of the flattened end of the bar is used, as indicated in Fig. 7, for raising or prying heavy objects apart. The pointed end of the bar may be used to align holes in plates as indicated in Fig. 8. The bar is also used in repair work, and when installing plates inside of a hull.

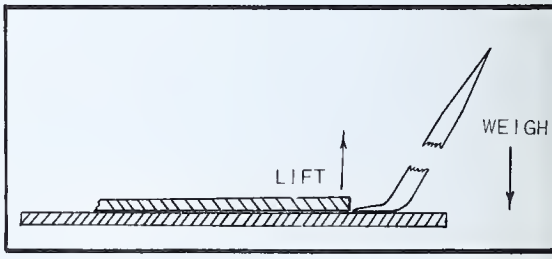


Fig. 7 — *Lifting Heavy Plates*

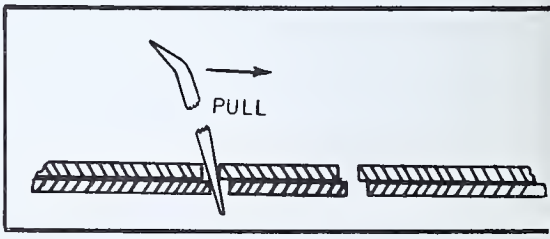


Fig. 8 — *Aligning Holes With a Spud Bar*

The Maul

The maul, also termed a hammer or sledge, is used in mauling, beating or driving when working with drift pins, wedges and flatters.

The erector should swing the maul (usually an eight-pound size) with a rhythmic motion of the arms and body, using the full length of the maul

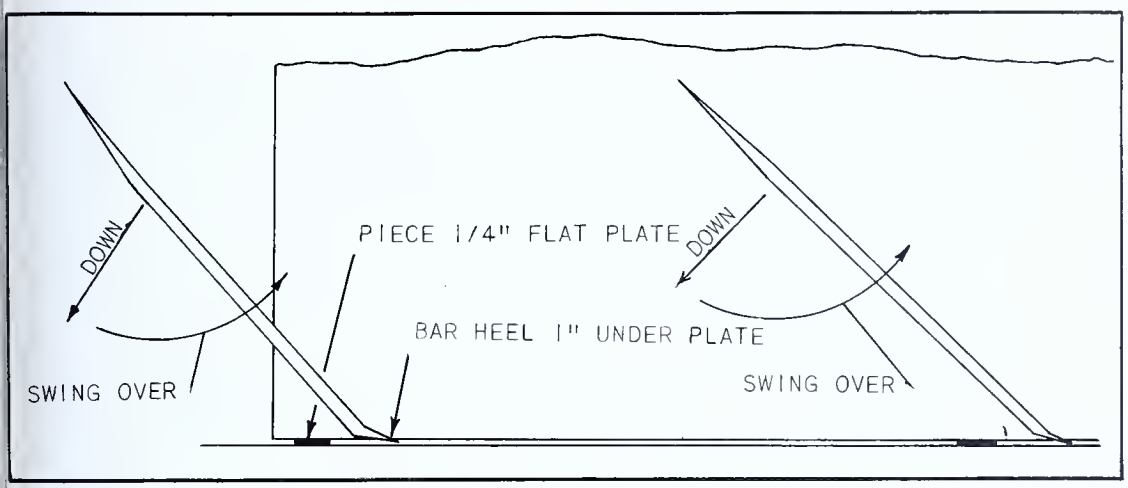


Fig. 9 — *Walking a Plate*

handle, rather than taking a grip high up on the handle. In addition, he should deliver a flush or flat blow with the maul, so that the steel will not be unnecessarily marked.

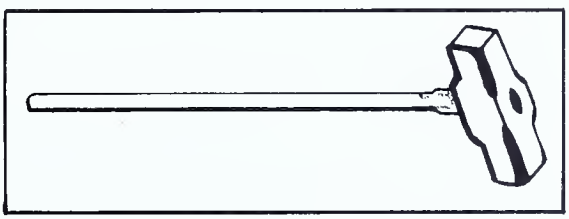


Fig. 10 — *Maul*

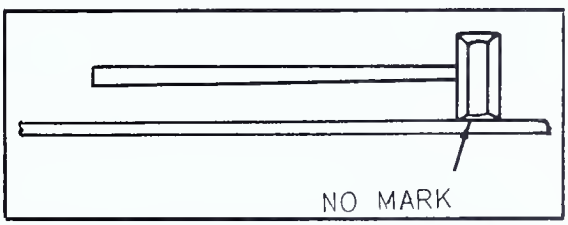


Fig. 11 — *Right Way to Use Maul*

Pneumatic Wrench

The pneumatic wrench is extensively used where many bolts are needed in erecting, or where a connection requires much force to pull it together. Much time will be saved by using the pneumatic wrench.

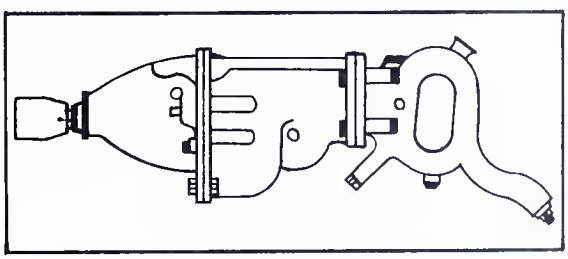


Fig. 12 — *Pneumatic Wrench*

Certain safety features must be observed when using a pneumatic wrench. The correct size chuck or socket must be selected for the size of the nut to be used. Try the rotation by a light pressure on the air trigger before setting the socket on the nut. If the rotation is not in the desired direction, reverse the small trip lever on the machine. The position of the forward and reverse trip is to be watched at all times. In that all erection jobs do not require the same amount of pressure, the erector must control the force applied by means of the pneumatic wrench. If a nut is removed instead of tightened, an accident might result which could have been avoided by checking the rotation of the wrench.

C Clamps

The C clamps are used on hand work where it is necessary to hang a cha block or rope block for work to be performed under a deck. These clam must not be used when hoisting loads exceeding two tons. C clamps a burned from scrap stock at least 5/8" in thickness.

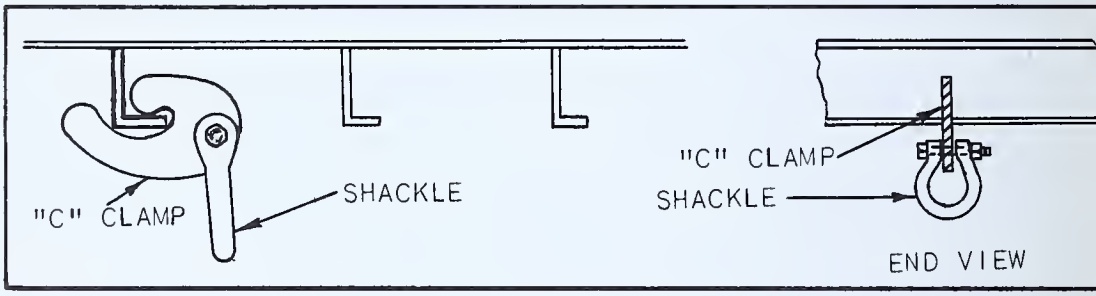


Fig. 13 — *Use of C Clamps*

The Drift Pin

The drift pin is used when aligning holes, liners, shell plates, frame co nections, or any other place where trouble is encountered in making up connection. The pin is mauled into the hole until the member has be properly shifted. These pins remain in the shell plate connections to preve slipping of the connection.

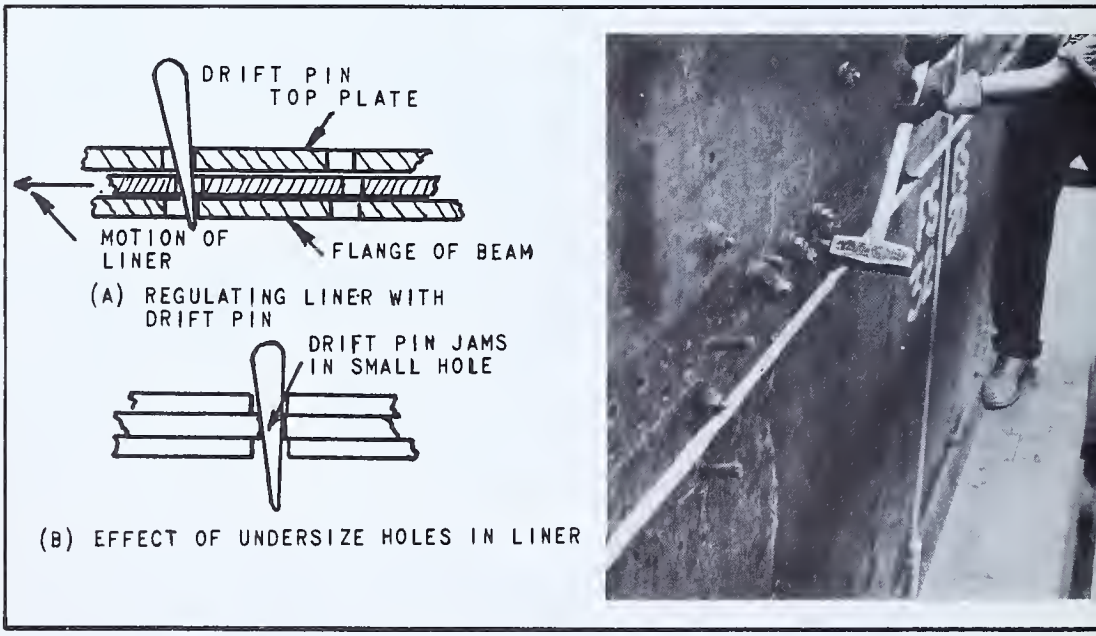

DRIFT PIN
TOP PLATE
MOTION OF LINER
FLANGE OF BEAM
(A) REGULATING LINER WITH DRIFT PIN
DRIFT PIN JAMS IN SMALL HOLE
(B) EFFECT OF UNDERSIZE HOLES IN LINER

Fig. 14 — *Use of Drift Pins*

These pins range in size from 5/8" to about 1 1/8". The pins are all abo 8 inches long and taper to a point. The 7/8" and 1" sizes are commonly use

Painting Connecting Surfaces

When working on riveted construction where there is to be no oil cargo, it will be necessary to paint all connecting surfaces with at least one coat of red lead paint, or specified paint, to prevent rust and corrosion between two members. This makes it necessary for the erecting gang to always have a paint pot and a three or four inch brush with them.

Six Foot Rule and Soapstone

Erectors should always have a six-foot rule and a piece of soapstone on hand for making measurements and necessary markings. Soapstone usually can be obtained in one of the yard's tool rooms.

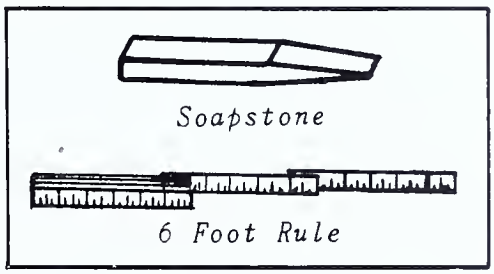


Fig. 15

Steel Wedges

These wedges are used for raising or lowering operations where dogs are brought into use.

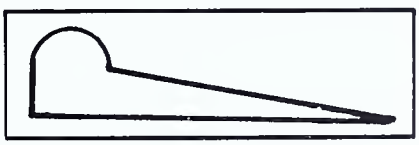


Fig. 16 — *Steel Wedge*

QUESTIONS

1. **What are the three tools most commonly used by the ship erector?**
2. **How is a bar used to walk a plate?**
3. **What precautions are to be observed in the use of the pneumatic wrench?**
4. **How should a maul be used to prevent marking the iron?**
5. **List three uses of a spud wrench.**

Part IV

EQUIPMENT — STRESSES AND BREAKING STRAINS

The ship erector must handle and erect large ship assemblies requiring the use of several types of hoisting equipment. (This section describes this equipment and indicates how it is to be used.)

Types of Cranes and Capacities

The Overhead Crane

Overhead cranes operate from girders spanning one high craneway to another. See Fig. 17. The capacities of these cranes are plainly marked. Some cranes have two hoists, one called the auxiliary, and the other the main hoist. When loads beyond their individual capacities are to be handled, two cranes must be used instead of one. This is accomplished by the use of an equalizer. See Fig. 17. The equalizer is so made that when the load is attached to the lifting eye, each crane will support its proportionate part of the load. The ends of the equalizer are spaced far enough apart so that both cranes may be operated without interfering with each other.

Fig. 17 — *Two Overhead Cranes With Equalizer*

The Gantry Crane

The gantry crane, also termed a "whirler", a "revolving crane", or a "boom crane", has its working capacity determined by the radius of its boom. This radius is the horizontal distance from the center of the crane to the center point of the load when hanging from the boom. The radius may be increased or decreased by lowering or raising the

boom — more commonly called "booming up" or "booming down." A cran with a 50 ton capacity at a 65 foot radius has its capacity decreased to 1 tons at a 110 foot radius. As the boom is lowered the leverage become greater in its action against the counterbalance which is in the rear of th crane. Overloading a gantry crane with too great a boom radius can pull th crane over; when handling heavy loads always be sure the boom setting i proper for the load to be hoisted.

The gantry crane runs upon wheels on a track. The track extends from one end of the shipway to the other, making the crane available to any part of the ship at all times. The gantry itself works on a circular base, and can be turned in any direction (hence the name "whirler"). By raising and lowering the boom it can reach material which is placed at some distance from the track, as long as the weight is not more than the capacity for that radius. The boom is not moved up or down unnecessarily since this operation takes longer than to travel the crane and swing. When it is desired to hoist an object which lies close to the base of the crane, the crane is traveled down the track and swung around so that the object can be reached. This operation is quicker than raising the boom.

FIG. 18 — *A Gantry Crane*

Crane Signals

Crane signals used by the United States Reclamation Service, and by mos shipyards, are illustrated in Fig. 19.

EXPLANATION OF SIGNALS

1. Hoist (Raise the load) — Point upward, wave the forefinger in a circle.
2. Lower (Lower the load) — Up and down flapping motion of the wrist wit palm of hand downward.
3. Hoist Slowly — With the forefinger draw a circle in the palm of the left hand
4. Stop — Move the outstretched hand back and forth slowly.
5. Emergency Stop — A vigorous sweeping motion of the hand and arm back an forth at about waist level.

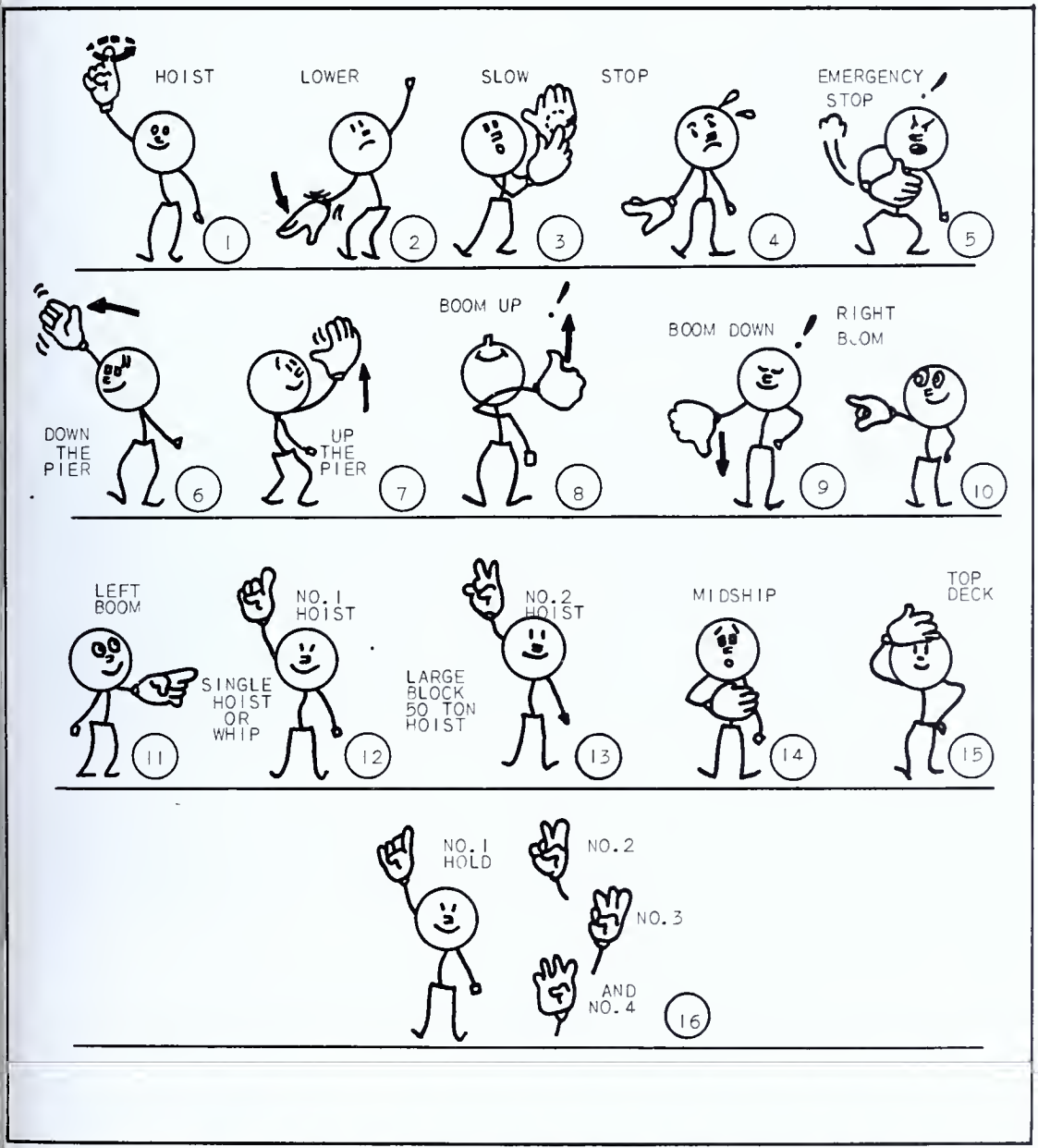


FIG. 19 — *Crane Signals*

6. Down the Pier or Down the Track (Crane to travel away from signaler) — Wave the hand in a "go away" motion.
7. Up the Pier or Up the Track (Crane to travel toward the signaler) — Wave the hand in the "come to me" motion.
8. Boom Up (Elevate the boom of the crane) — Upward jerking motion of the thumb.
9. Boom Down (Lower the boom of the crane) — Downward jerking motion of the thumb.
10. Right Boom (Move the boom to the right) — Point with finger to right hand side.
11. Left Boom (Move the boom to the left) — Point with finger to left hand side.

Signals for Designating Hoist to be Used

12. Raise one finger for small hoist.
13. Raise two fingers for large hoist.

Location on Ship of Loads Being Sent Up

14. Midship — Place hand on stomach, meaning center of ship.
15. Top Deck — Hold hand on top of head.
16. Number of Cargo Hold — 1 finger for No. 1; 2 fingers for No. 2; 3 fingers f No. 3, and so on to numbers of whatever cargo hold is used.

Engine Room — Use both hands in revolving motion similar to pistons on engi

Use Proper Signals

The signal man should be careful to give the proper signals at all time and to see that his signal is clear and is understood. A misunderstood sign may lead to a controversy with the crane operator when the fault may be th of the man giving the signal. While signaling, sometimes look at your sign hand yourself and see if you are giving the signal properly. On fogg cloudy days, or when working where smoke is rising out of a hold, the cra operator may have difficulty in seeing a signal man's hand. It is advisab under these conditions to remove gloves before signaling.

Signals for Night Workers

While working at night the operator cannot always see the signal ma therefore, night signals are often given by whistle, or by the use of a flas light. The whistle signals are:

1 blast — Stop (At any time).
2 blasts — Hoist (Raise the Load).
3 blasts — Lower the load.
4 blasts — Move aft.
5 blasts — Move forward.
1 short and 1 long blast — Move to port.
1 short and 2 long blasts — Move to starboard.

When working by whistle blasts always remember that there are ma noises in a shipyard. The operator may not always hear the whistle and times other noises may confuse him. The use of a whistle in signaling is n recommended — the chance of making a mistake is too great.

Flashlight Signals

Flashlight signals are used for night work, since they are more reliab and are more easily seen and recognized than whistle signals. The light turned on, pointed upward, and waved in a circular motion for "Hoist";

is waved up and down in a perpendicular swing for "Lower"; and is swung back and forth in a horizontal plane for "stop". Light signals sometimes are given by blinking the light. When signaling with a blinking light, the light is flashed the same number of times as blasts of the whistle: one blink to stop, two to go up, three to lower, four to move aft, five to move forward, one short and one long to move to port, and one short and two long to move to starboard.

Relaying Signals

When working in a lower position over the port side of the ship or when working in any cargo tank or engine room it may be necessary to relay signals. A signal relayed from the man on the job to the signal man at the top of the ship and then to the crane operator, may not receive an immediate response. When relaying signals, take into consideration the time necessary for relaying so that the crane will not hoist beyond the desired position. In some such cases it would be possible to break the hoisting equipment and perhaps drop the load. Lifting anything which connects on the under side

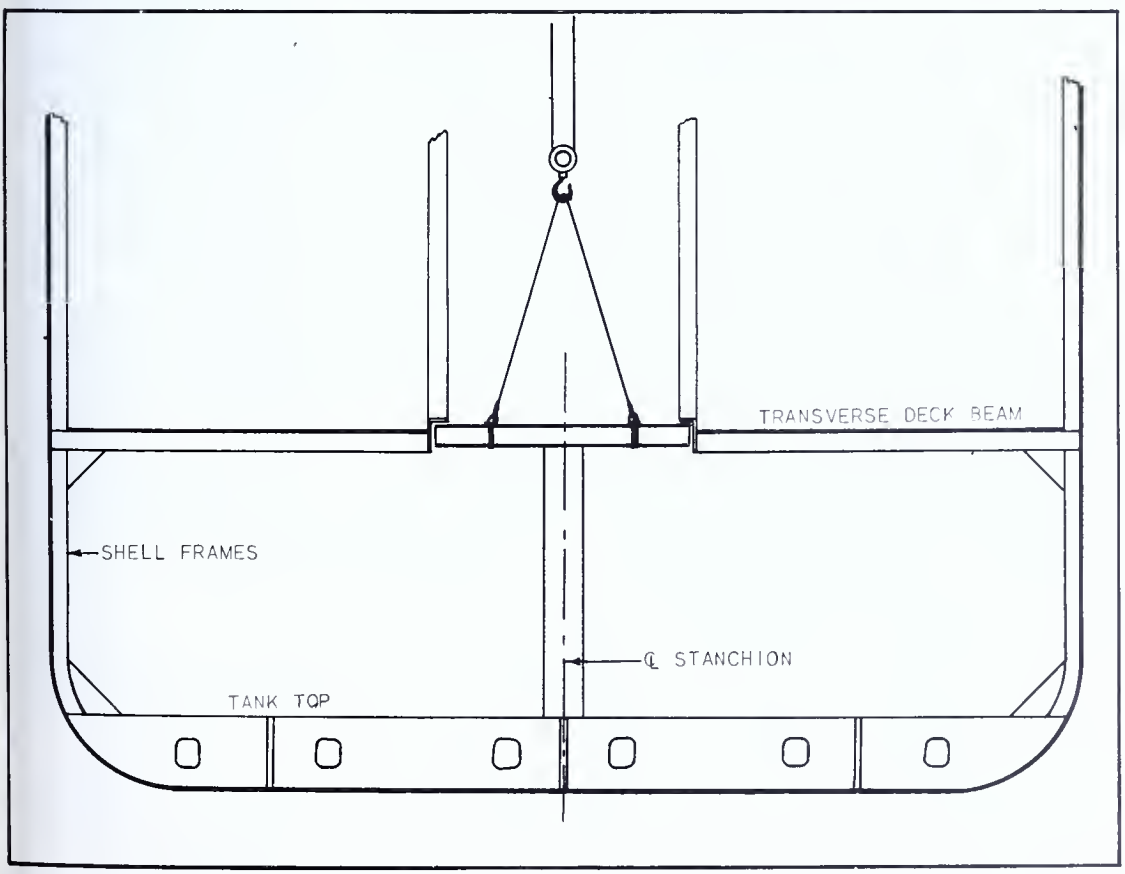


Fig. 20 — *Transverse Deck Beam and Shell Frames (Elevation)*

to another object is dangerous. The "Stop" signal should be given before the object has reached the point where you want it to stop. Should the object stop before it has reached the proper place, a slight additional "slowly hoist" signal would complete the operation without causing an accident. *Do not take chances. Learn to give your signal correctly.*

Wire Rope Pennants

For outside erecting and hoisting, where large and heavy loads are to be carried over other workmen and over the ship, the use of wire rope pennants is the safest handling method. Pennants are made of wire rope with an eye spliced in each end. These pennants are made in any length and of any required size of cable.

Erectors generally use pennants in pairs. See Fig. 21 "A". A commonly used pennant is made from ¾" wire rope, about 18 feet long, with a 16" eye. Smaller wire and shorter lengths are used as chokers for wrapping around individual loads, or in other places where needed. The pennants used for large bulkheads are of 1¼" wire rope, 36 feet long, with 24" eyes. These are used double with both eyes placed on one shackle; the loop formed at the middle of the pennant being placed on the hook of the crane. When two pennants are used together in this manner the carrying capacity is double that of a pair of single pennants of the same diameter.

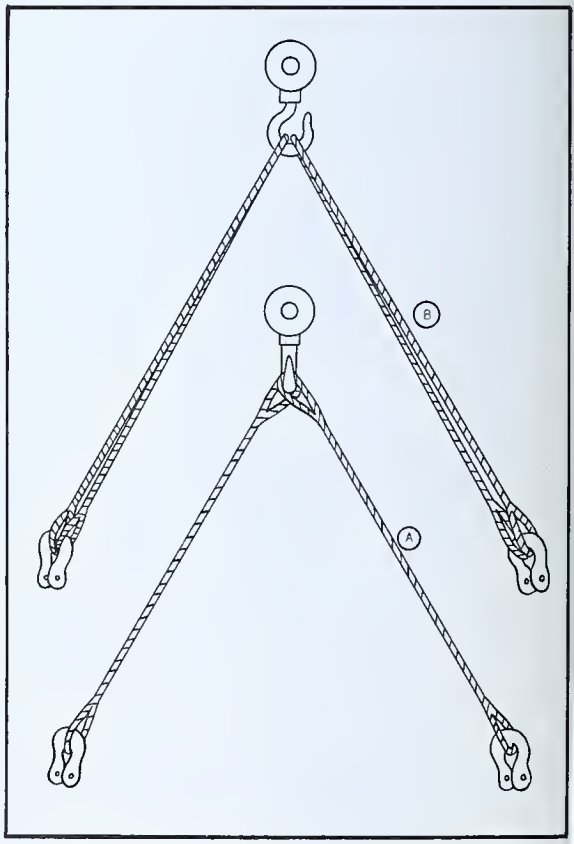


Fig. 21 — *Single and Double Wire Rope Pennants*

Use of Hook Pennants

Hook pennants are used in sets of four for handling bulkheads, decks, and all loads that are to be moved around in a flat position. These hook pennants are made of wire rope in various lengths, usually about 14 to 16 feet long with an eye about 24" long spliced in one end and a large hook spliced into an eye about 12" long on the other end. Hook pennants for lifting different capacities are made from ¾" to 1¼" size wire rope. See Fig. 76.

TABLE I

SAFE LOAD IN POUNDS FOR CHAIN, WIRE ROPE, AND MANILA ROPE SLINGS

(Loads Specified Must Not be Exceeded)

DIA.	CHAIN — P. D. SPEC. 1591				WIRE ROPE — P. D. SPEC. 3105				MANILA ROPE — P.D. SPEC. 3106			
	USED STRAIGHT	USED AT 60° ANGLE	USED AT 45° ANGLE	USED AT 30° ANGLE	USED STRAIGHT	USED AT 60° ANGLE	USED AT 45° ANGLE	USED AT 30° ANGLE	USED STRAIGHT	USED AT 60° ANGLE	USED AT 45° ANGLE	USED AT 30° ANGLE
3/8	1800	1550	1250	900	2050	1750	1450	1000	200	170	140	100
1/2	3000	2600	2100	1500	3700	3200	2600	1850	340	290	240	170
5/8	4600	4000	3250	2300	5600	4850	3950	2800	560	480	400	280
3/4	6750	5850	4800	3400	8050	7000	5700	4000	690	600	490	350
7/8	9350	8100	6600	4670	10800	9350	7650	5400	980	850	690	490
1	12400	10700	8750	6200	14000	12100	9900	7000	1150	1000	810	580
1 1/8	15600	13500	11000	7800	17600	15200	12400	8800	1550	1350	1100	780
1 1/4	19200	16600	13600	9600	22000	19000	15500	11000	1750	1500	1250	880
1 3/8	23000	19900	16300	11500	27200	23600	19200	13600	2240	1950	1600	1100
1 1/2	27200	23600	19200	13600	32000	27700	22600	16000	2450	2100	1750	1200
1 3/4	35000	30300	24700	17500	43200	37400	30500	21600	3550	3100	2500	1800
2	44400	38500	31400	22200	52000	45000	36800	26000	4200	3650	2950	2100
2 1/2	69600	60300	49200	34800	85600	75100	60500	42800	6100	5300	4300	3050
3									8550	7400	6050	4300

THE SAFE LOADS SPECIFIED IN THE TABLE ARE FOR EACH SINGLE CHAIN, WIRE OR MANILA ROPE.
WHEN USED DOUBLE, OR IN ANY OTHER MULTIPLE, THE LOAD MAY BE INCREASED PROPORTIONATELY.
IF, FOR EXAMPLE, THE SLING HAS 3 LEGS, THE LOAD MAY BE 3 TIMES THE LOAD SPECIFIED ABOVE.
STUB HOOKS TO BE USED FOR LIFTING APPARATUS, WHICH IS PROVIDED WITH HOLES FOR THAT PURPOSE.

Wheel Strap

One short choker of 1″ wire rope about 6 feet long with an eye of abou 20″ in each end, when used double, is termed a "wheel strap." It is use when the need arises to lengthen a hook-up.

Table I shows the safe working loads of various sizes of wire rope, chain and manila rope, when used at different angles. Referring to Table I, w find that ¾″ wire rope has a safe working load of 8050 pounds when use straight.

Table II shows the breaking strain in tons of all sizes of wire rope. W find that the ¾″ size has a breaking strength of 22.8 tons, or 45,600 pounds

TABLE II

BREAKING STRENGTH IN TONS OF PLIABLE WIRE HOISTING ROPE

SIZE IN INCHES	BREAKING STRENGTH IN TONS OF 2,000 POUNDS	SIZE IN INCHES	BREAKING STRENGTH IN TONS OF 2,000 POUNDS
1/4	2.8	1-1/2	88.2
3/8	6.1	1-5/8	103.3
1/2	10.6	1-3/4	119.5
5/8	16.1	2"	155.0
3/4	22.8	2-1/4	194.0
7/8	30.5	2-1/2	237.0
1"	39.5	2-3/4	285.0
1-1/8	49.9	3"	337.0
1-1/4	61.5	3-1/4	392.0
1-3/8	74.3	3-1/2	451.0

(Caution: This table presents *breaking* strength — *not* safe working loads)

By comparing the breaking strain (45,600 lbs.) with the safe working loa (8050 lbs.) one may determine that the breaking load is slightly over 5½ times as great as the safe working load. This relationship may be expresse as "5½ to 1".

Since some shipyards use chain as a hoisting agent instead of rope, thes similar figures can be worked out by referring to the table on safe workin loads.

Shackles

Two sizes of shackles frequently are used in the shipyard. When used pairs, small shackles with ¾″ wire rope pennants will hoist loads up to t

tons. When used singly, they are limited to a hoist of five tons. These shackles are about 8″ in diameter and are made from *special bar steel,* approximately 1¼″ in diameter.

The large shackles, used for hoisting bulkheads and for other heavy lifts, should have a safe working load of 70 tons when used in pairs. The shackle itself is about 14″ long, and uses a 2½″ diameter steel shackle bolt.

Shackles of all sizes should be frequently examined to see that the spread between the eyes does not become too great. When the eye has spread the shackle bolt may bend. Bent shackles do not have full strength. If shackles become spread they should be taken to the blacksmith shop where they will be heated and reshaped. A shackle should not be reshaped cold, since so doing may fracture the metal.

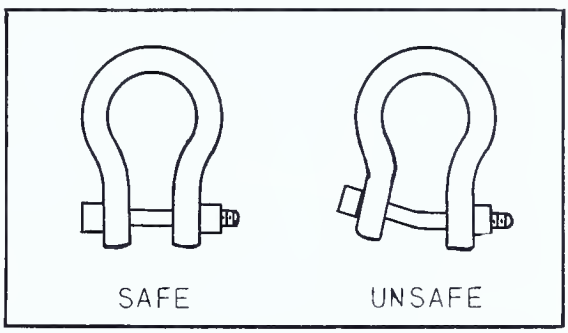


FIG. 22 — *Safe and Unsafe Shackles*

SHACKLE BOLTS

Shackle bolts for the smaller shackles are available in special steel in sizes ranging from ⅜″ to 1″. The shear value of special steel shackle bolts may be seen by referring to Table III. Three-quarter inch shackle bolts, which is the size generally used, have a shear value of 21,204 pounds when used in double shear, which is one fifth of the critical or breaking point of the bolt. When the shackle bolt is used in a shackle it does not give the full

TABLE III

LENGTH OF WELD TO EQUAL SHEAR STRENGTH OF SPECIAL STEEL BOLTS

Bolt in single shear

Bolt Dia.	Shear value	Length of 1/4" bead
3/4"	10,602	4-1/2"
7/8"	14,432	6"
1"	18,850	7-3/4"

Bolt in double shear

Bolt Dia.	Shear value	Length of 1/4" bead	Length of 3/8" bead
3/4"	21,204	9"	5-5/8"
7/8"	28,864	12"	7-3/4"
1"	37,700	15-1/2"	10"

double shear value, since the shackle does not fit closely enough to provide a bearing surface over the entire length of the bolt. However, its value will be sufficient for safe loads with ¾″ wire pennants. The safe load of a special steel shackle bolt (considered as being 20,000 pounds), if compared to the

safe load of the 3/4" wire pennant (which is 8050 lbs.) clearly indicates that the shackle bolt has a greater safe working load than the 3/4" wire pennant.

Screw Dog

Screw dogs primarily are used in handling all-weld work (having no rivet holes) where shackles can not be used for handling. See Fig. 23. Screw dogs must be used in the correct manner; it is unsafe to do otherwise. When using two dogs, do not spread them too great a distance apart, since this causes excessive side pull, with the probability that one of the dogs might be pulled off. See Fig. 23 "A". When applying the dog to the edge of the plate, clearance must be provided between the rounded part and the plate opening and the top of the plate. See Fig. 23 "B". Raise this rounded part about 1/2" above the edge of the plate before tightening the screw. If this is not done, the plate will have a slight opening at the back owing to binding on the rounded part at the top of the dog, and when hoisted the plate is likely to slip out of the dog. Tighten all dogs firmly by using the bar as a lever, but do not use enough leverage to strip the threads of the screw. Discard screw dogs having defective or badly worn threads.

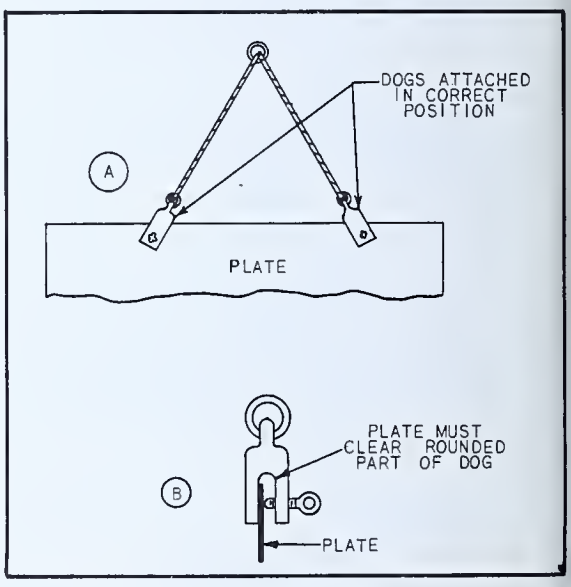


Fig. 23 — *Methods of Attaching Screw Dogs*

When used in pairs screw dogs will support a maximum load of six or seven tons. Never stand under loads which are being hoisted with dogs — there is too much chance of them becoming loose and allowing the load to fall. When hoisting material near previously-erected parts of the ship, see that the screw of the dog does not catch on the edge of a plate and break off. If the screw does break, it will be necessary to remove the dog from the plate by burning with a torch.

Various Lifting Pads

The Lifting pads shown in Fig. 24 include both the welded and the bolted type. In some instances a combination of both is used. When lifting pads are applied to large sections, a safe working load capacity is usually determined

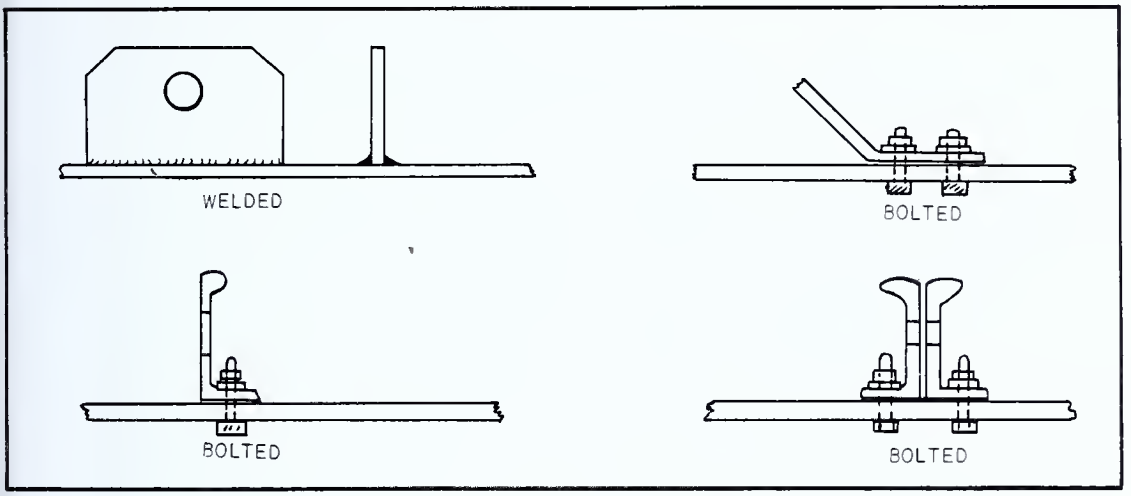


FIG. 24 — *Pads Used in Lifting*

before they are installed. However, in handling, welds may become cracked or broken, bolts become loosened, and the pads themselves may become bent or be broken off. *When attaching heavy loads by means of these pads, make it a rule always to inspect the pads to see that the weld is in good condition, that bolts are tight, and that the pads themselves have not become broken.*

Most lifting pads installed on heavy structures are intended for use with large hook pennants or shackles with 2½" diameter bolts. Do not hook to a pad that you do not believe safe without first bringing the condition to the attention of your leader or foreman.

STEAMBOAT RATCHETS (AND TURNBUCKLES)

The following methods are employed when it is necessary to use a steamboat ratchet to pull together two adjacent sections of deck or shell plating.

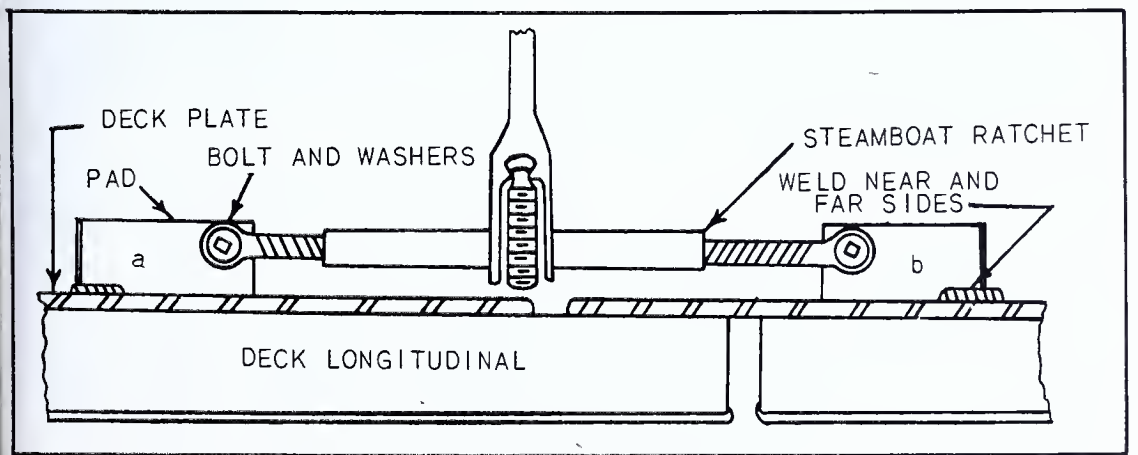


FIG. 25 — *Pulling Deck Sections With a Steamboat Ratchet*

The pads into which the turnbuckle is bolted should, whenever possible, be welded on the top side of the plate directly opposite a longitudinal or stiffener, to avoid bending the plates.

One method of using a ratchet is illustrated in Figure 25. This procedure is used when the two sections may be expected to come together with an average amount of pull. The pads "a" and "b" have holes for securely bolting the ends of the turnbuckle. When the pad is welded on in the position shown, the holes should be high enough above the deck (about 4″) for the spur teeth in the center of the ratchet to be clear of the plating.

In Fig. 26 are shown the approximate dimensions of the ordinary pad to be used in this manner. A two-inch landing should be used for the holes in the corners. Care should be taken to have the hole in the pad burned out very smoothly, or punched, so that the corner will not be likely to tear out before the full strength of the bolt is utilized.

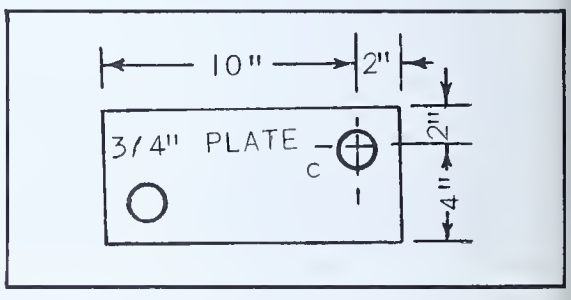


Fig. 26 — *Pad for Use with Ratchet*

Taking Up Clearances

In Fig. 27, at "a" is a washer between the pad and the turnbuckle, used to take up the clearance which would otherwise occur, owing to the shoulder on the eye of the ratchet. Without this washer, the bolt used would bend and fail before its full strength could be used. This bolt must always be pulled up tight. The weld at "b" in Fig. 27 runs around the end of the pad and is evenly applied on both sides.

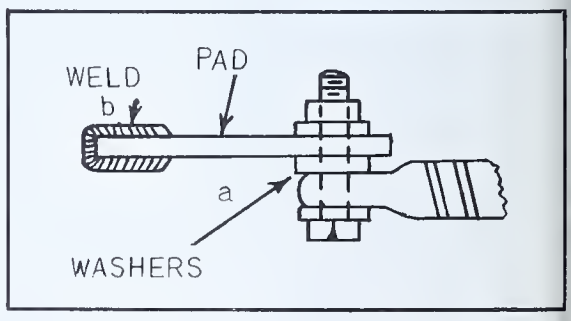


Fig. 27 — *Bolt in Single Shear*

Fig. 28 shows how the same type pad can be used to put a bolt in double shear. The bolt in double shear is resisting the pull in two places and therefore will hold twice as much strain.

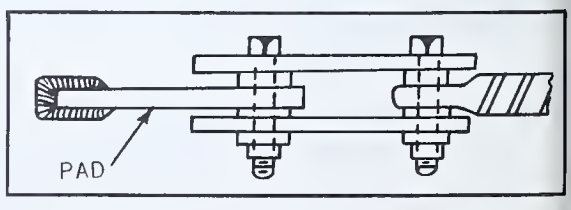


Fig. 28 — *Bolts in Double Shear*

Welding Two Pads to the Deck

Another method of putting a bolt in double shear is by welding two pads to the deck instead of one (Fig. 29).

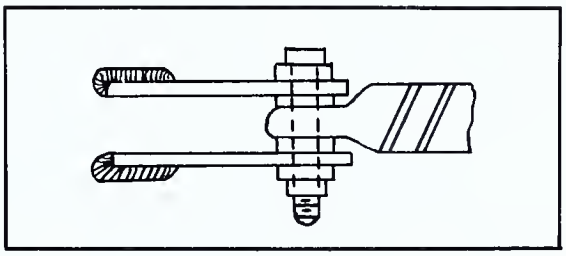


Fig. 29 — *Single Bolt in Double Shear*

When it is impossible to place the pads over or opposite a longitudinal or stiffener, a flat bar about three feet long may be used at each end of the turnbuckle, as shown in Fig. 30. The bar is bent to an offset and one end welded to the deck at "a". The ratchet is bolted to the other end of the flat bar, a wood or steel block being placed under the bolt to keep the ratchet gear clear of the deck. This arrangement prevents the plate from bending downward, as it would with the use of a short pad. The block should be long enough to spread the pressure over a large area of plating. The same result can be obtained by using an angle or T-bar clip about three feet long, as shown in Fig. 31.

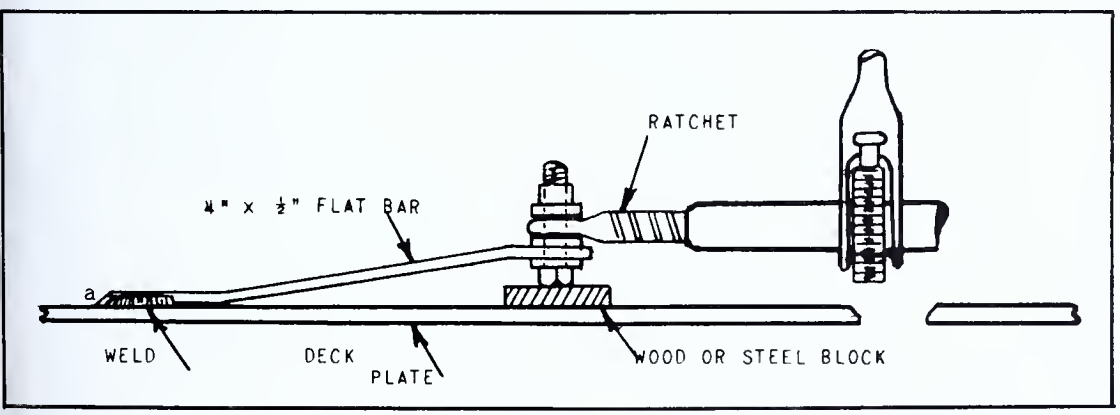


Fig. 30 — *Rachet Connection to Deck When No Longitudinal is Beneath*

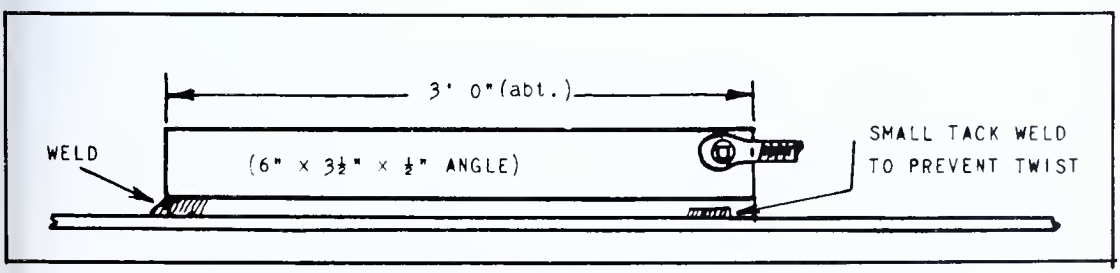


Fig. 31 — *Scrap Angle or T-Bar for Ratchet Connection*

Temporary Fastenings

Temporary fastenings are used while erecting shell plating and other all-weld members which do not have erecting holes. Temporary fastenings are the clip and bolt (Fig. 32), the step cut dog (Fig. 33-A), and the "U" dog, or yoke (Fig. 33-B).

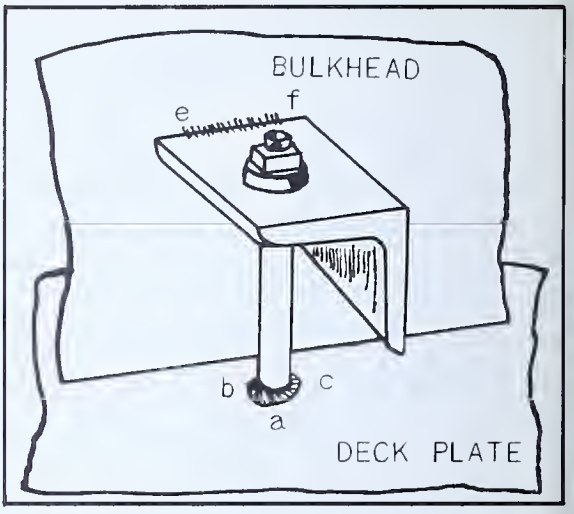


Fig. 32 — *Clip and Headless Bolt*

A. Clips and Bolts

Clips should always be welded to the bulkhead, or the framing, as shown in Fig. 34. The flange of the clip between "a" and "b", which has a hole for the bolt, is horizontal. The weld is made only along the top. The other flange of the clip, from "b" to "c", is downward. No weld is needed on this vertical flange because the force of the bolt pushes it tight against the bulkhead. Care should be taken when installing clips and bolts so that when the bolt is tightened the washer will bear flat on the clip. This will cause a uniform pull on the top weld and also prevent bending of the bolt. The bolt should be held in line with the hole, and the head of the bolt welded to the shell plate, or the member to be fastened, so that when the bolt is pulled tight the pull will be straight. If the piece erected is to be temporarily held in place by clips and bolts, install clips at frequent intervals so that the load will be safely supported when the crane is unhooked.

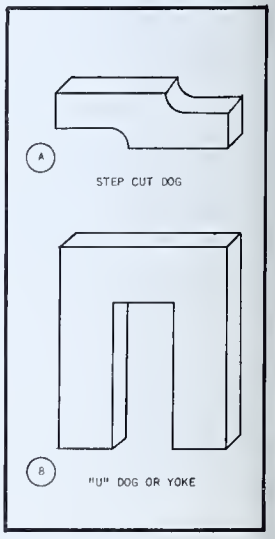


Fig. 33 — *Step Cut and "U" Dogs*

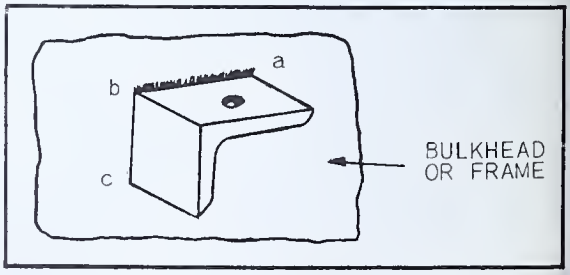


Fig. 34 — *Attachment of Clip*

B. Step Cut Dog

The step cut dog, Fig. 35-A, is used for erecting and aligning all-weld plates such as shell bottom plates aft or forward, or side shell sections. Fig. 35-B.

The dogs are applied as shown in Fig. 35-A, usually three to a plate. The dogs are fastened by welding only at the points "b" and "c", Fig. 35-A. Weld is required on one side only. When applying the steel wedge, drive from the side where the weld is applied; driving the wedge from the other side would cause the dog to break off. When step cut dogs are used as a means of supporting a plate after erecting, use at frequent intervals and apply sufficient weld to hold the plate safely in place.

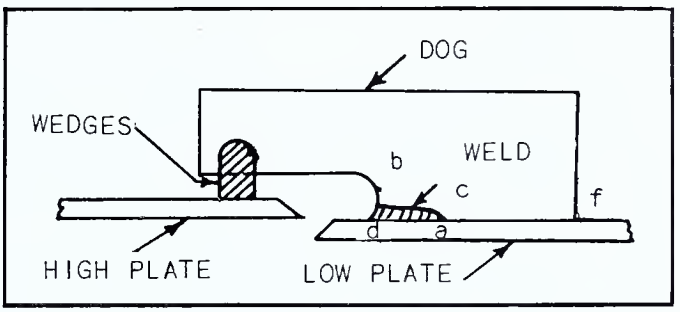


FIG. 35 A — *Use of Dog in Lining a Plate Butt*

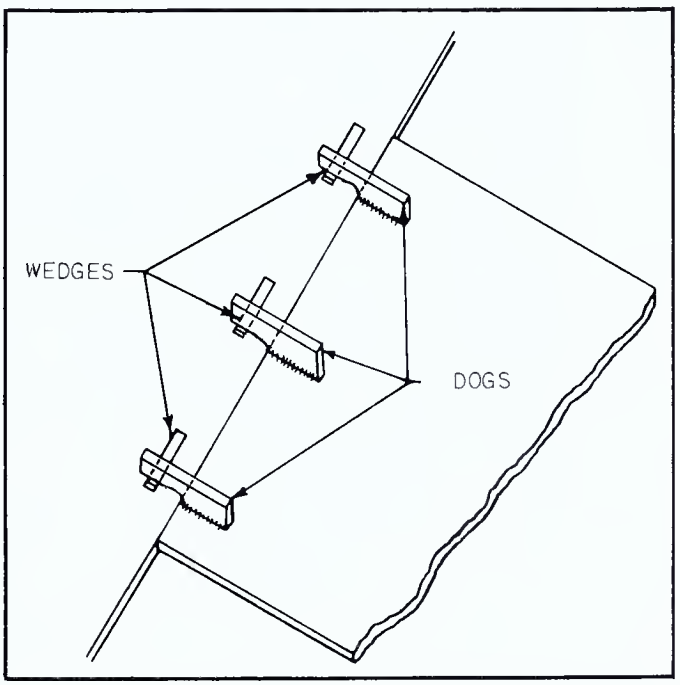


FIG. 35 B — *Step Dogs on Shell Plate*

A dog is burned from a piece of scrap plate from $\frac{3}{8}$" to 1" thick, depending upon the force needed to pull the plates into position. Usually heavy plating requires heavy dogs. In making a dog, the corner "b" should be rounded so that it will not tear when subjected to a strain. Fig. 35-A.

C. The U Dog, or the Yoke

The yoke, Fig. 36, is used as a means of fastening shell plates to the shell longitudinals. A shell plate may be erected and fastened to the framing by the use of clips and bolts, step cut dogs, or U dogs, or a combination of all of these. These temporary fastenings should be kept on the inside of the shell plating as much as possible. Weld clips, bolts, and dogs on the *inside* of shell plating, thus preventing unnecessary roughness of the exposed surface.

Bolts, Nuts, and Washers

In most shipyards bolts, nuts, and washers used by erectors, regulators, and reamers and bolters are kept in conveniently located bins.

Frequently used sizes of bolts, nuts, and washers, stocked near shipway:

5/8" x 2"	5/8" x 3"
3/4" x 3"	3/4" x 3 1/2"
7/8" x 3"	7/8" x 3 1/2"

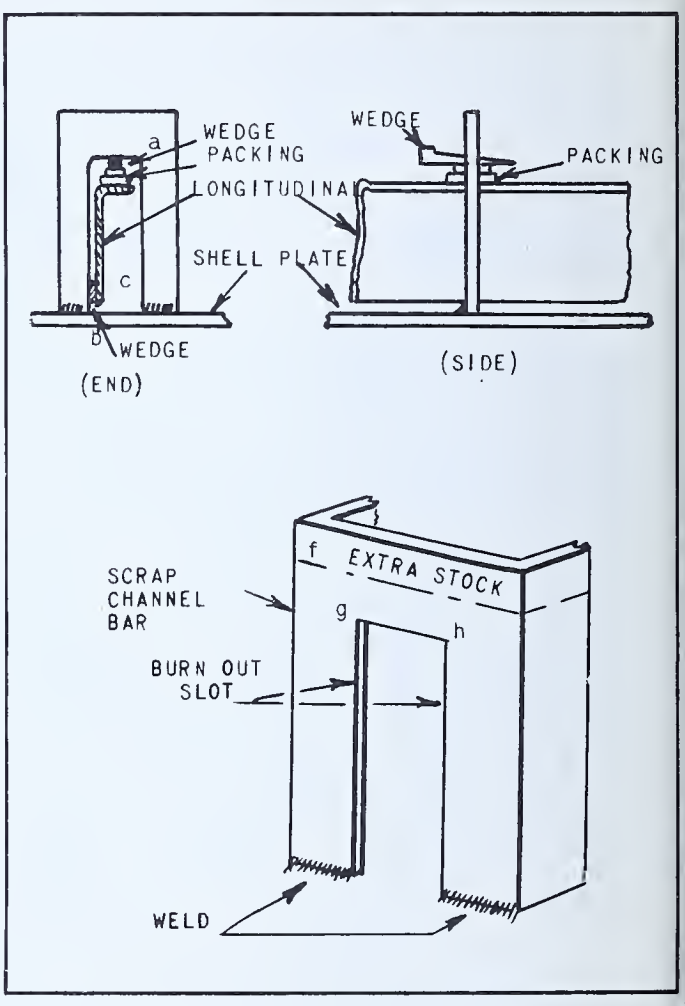


Fig. 36 — *Use of "U" Dogs*

Use of Bolts

When bolting connections use full size bolts, (that is, the largest size that can be inserted into a hole). Always place a washer on a bolt. Omitting the washer will cause the nut to cut into the plating, damaging the nut and scoring the plating. When a bolt is too long, washers are used to permit tightening. Since the last three or four threads on the bolt are not cut to full depth the nut must not be run all the way down. Before the nut is run down to the last threads, remove and place two or three washers on the bolt, replacing the nut, and tightening. If a nut has been run down to the last thread, it is necessary to hold the head of the bolt with one wrench while removing the nut with another. In this case the nut and bolt are ruined and should be thrown away.

Estimating Weights of Loads

Table IV, Thickness and Weights of Steel Plate, indicates that for every 1/8" thickness of plate per square foot, the weight is 5.1 pounds.

To estimate the weight of a plate 1" thick we need only to consider the 1' as 8/8" and multiply the 5.1 by 8, giving 40.8 pounds per square foot

TABLE IV
THICKNESS AND WEIGHTS OF STEEL PLATES

THICKNESS IN INCHES	WEIGHT IN LBS. PER SQUARE FT.	THICKNESS IN INCHES	WEIGHT IN LBS. PER SQUARE FT.
1/64	.638	53/64	21.05
1/32	1.28	17/32	21.7
3/64	1.91	35/64	22.3
1/16	2.55	9/16	22.95
5/64	3.19	37/64	23.6
3/32	3.83	19/32	24.25
7/64	4.46	39/64	24.87
1/8	5.10	5/8	25.5
9/64	5.74	41/64	26.18
5/32	6.38	21/32	26.8
11/64	7.02	43/64	27.4
3/16	7.65	11/16	28.05
13/64	8.30	45/64	28.7
7/32	8.93	23/32	29.35
15/64	9.58	47/64	30.0
1/4	10.20	3/4	30.6
17/64	10.85	49/64	31.26
9/32	11.50	25/32	31.9
19/64	12.12	51/64	32.5
5/16	12.75	13/16	33.2
21/64	13.40	53/64	33.8
11/32	14.03	27/32	34.4
23/64	14.68	55/64	35.1
3/8	15.30	7/8	35.7
25/64	15.95	57/64	36.4
13/32	16.60	29/32	37.0
27/64	17.22	59/64	37.6
7/16	17.85	15/16	38.25
29/64	18.5	61/64	38.9
15/32	19.14	31/32	39.6
31/64	19.79	63/64	40.2
1/2	20.4	1	40.8

Therefore, if a plate were six feet wide by thirty feet long, we would first find its total area by multiplying 6 times 30, which is 180 square feet. The area in square feet is then multiplied by 40.8, which will give us 7,344 pounds — the weight of the plate.

The weight of any plate of any size or any thickness may be estimated in this same manner. To calculate the weight of a bulkhead would necessitate the estimation of the weight of all its different parts, such as bulkhead plating, longitudinals, vertical stiffeners, flat plates, brackets and small fittings. When the estimated weights of all these parts are added together, the total weight of the bulkhead would be known. All plate thicknesses may be worked

from the basic weight of 5.1 pounds per square foot per $\frac{1}{8}''$ thickness of metal. For a quick estimate of the weight of objects on the job, an erector need remember only that 1 square foot of metal $\frac{1}{8}''$ thick weighs 5.1 pounds.

QUESTIONS

1. **List the equipment used by erectors.**
2. **What is the safe working load of a $\frac{3}{4}''$ wire rope pennant?**
3. **What is its breaking strain?**
4. **Does the angle at which a pennant is hooked affect its safe capacity? Explain.**
5. **What is meant by double shear?**
6. **What is the double shear value of a special steel bolt?**
7. **What is the weight per square foot of plate $\frac{1}{8}''$ thick?**
8. **Approximately how heavy is a plate 30′ by 8′ by $\frac{3}{4}''$?**
9. **What is the proper method of using screw dogs?**
10. **How tight should a screw dog be applied?**

Part V

STORING, IDENTIFICATION, AND HANDLING MATERIAL

Storing Material

Most parts of the ship are assembled in the fabrication shops. As these parts are completed they are placed at the shop opening, or "door," at the front of the shipways. Material collecting here must be removed to make way for more assemblies. The parts which are not needed for erecting are removed and are conveniently stored for later use.

Shell plating is stored in plate racks, except those plates which are rolled or shaped. These shaped plates are laid on the ground in a

FIG. 37 — *Material at Door of Shop*

FIG. 38 — *Plates Stored in Racks*

neat pile. House bulkheads are stored where they may be racked against a solid object. Care must be exercised not to lean assemblies against stage towers or objects which may break down or bend under their weight.

Shell frames are stored aft along the side of the ship or along the midship side, if an available space can be located. Loose brackets are stored at the

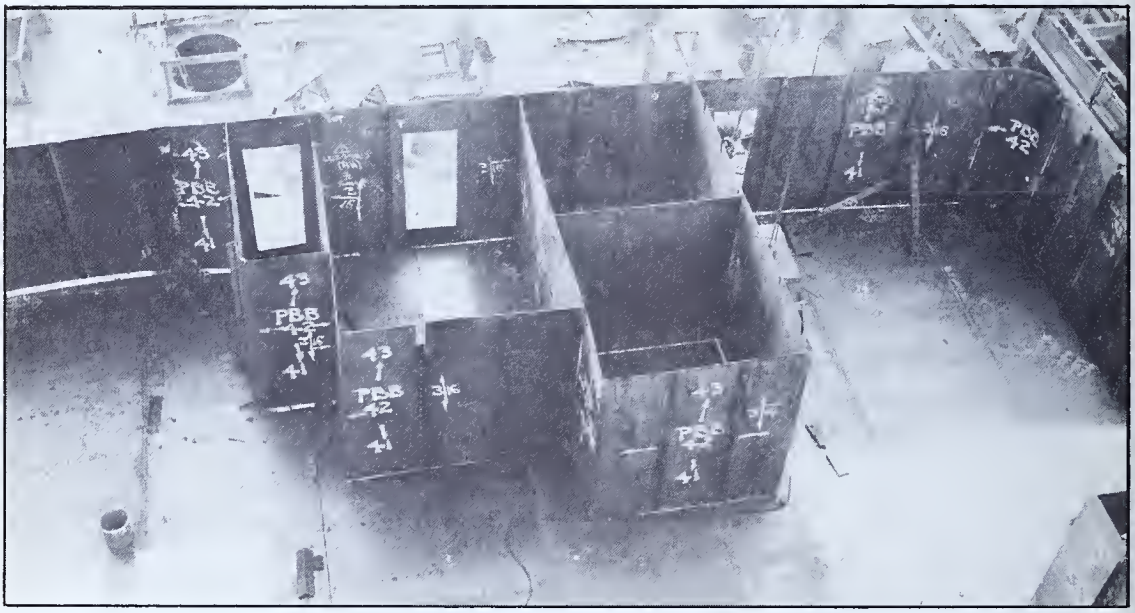


FIG. 39 — *Deck House Bulkheads*

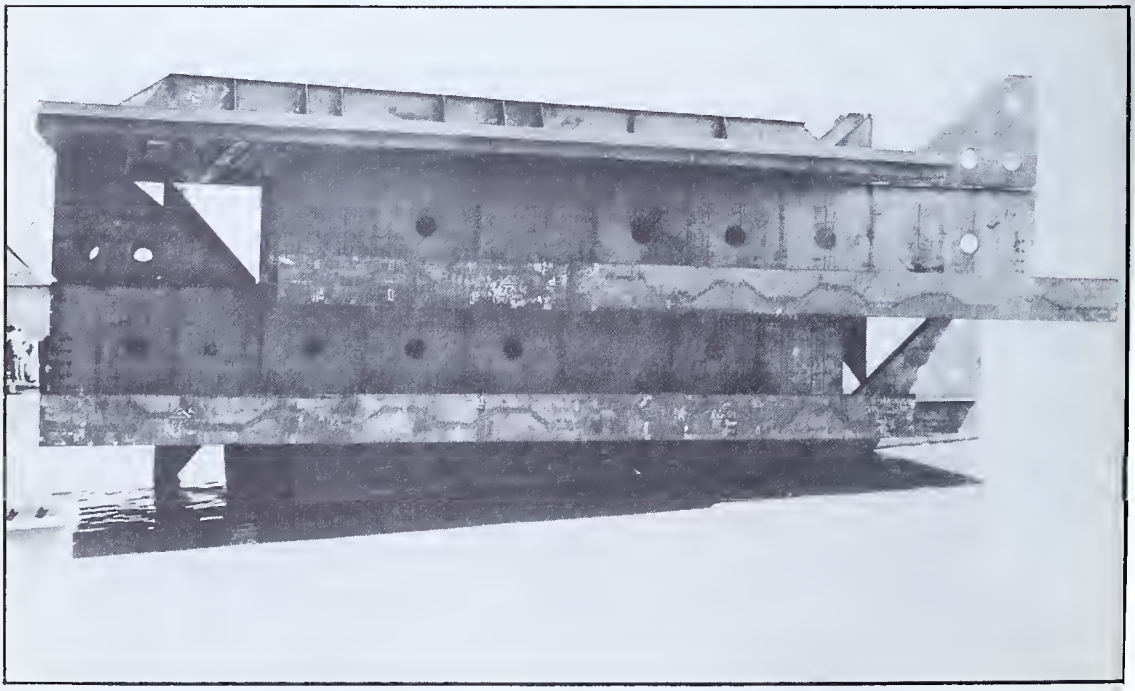


FIG. 40 — *Large Bulkheads in Storage*

forward end of the shipway when possible. Shell liners are also stored at the forward end of the shipway. Deck sections are stacked where sufficient space can be found. Large bulkheads are stored flat.

The shell plates are placed at the "door" in a pile, one on top of another. When removed by the erectors for storing, they should be sorted and stored in a correct order, making it possible to get any plate wanted at any time without having to move a number of plates. To rack plates properly the erector must understand shell plate markings.

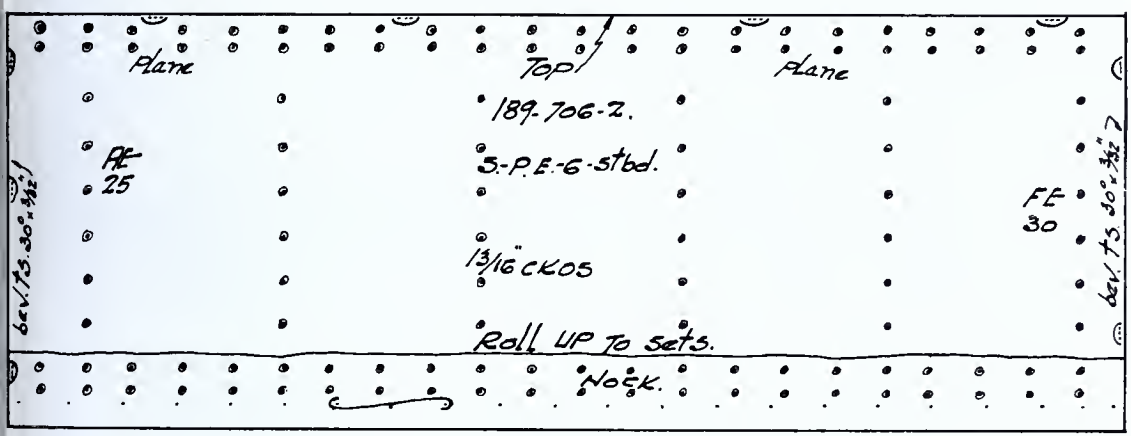


FIG. 41 — *Shell Plate With Markings*

Fig. 41 shows a shell plate with markings which are typical of those used on other sections erected in the yard. Reading from left to right on the plate we find:

bev.ts.30° x 3/32″ — (Bevel plane this side 30° starting 3/32″ from edge of plate.)

Plane — (Plane a square edge on that side of the plate.)

AE25 — (This end of the plate fastens to frame number 25.)

Top — (This designates the top edge of the plate.)

189 — (Hull number — meaning the 189th hull contract received by the yard.)

706-2 — (Shell plating drawing charge number. All drawings of different parts of the ship are listed by charge numbers, as, framing 710, bulkheads transverse 717, bulkheads longitudinal 718, deck plating 715, etc. Table V lists typical charge numbers.)

E — (The strake. A fore and aft row of shell or other plating. Shell plating strakes are F. K. (flat keel) A strake, B strake, C strake, etc.)

6 — E6 — (The strake number. Strakes start at forward end with No. 1, 2, 3, progressing aft. The E6 means the sixth plate of the E strake.)

TABLE V

STANDARD CHARGE NUMBERS FOR HULL DRAWINGS

(As Used by Sun Shipbuilding and Dry Dock Company)

700 — Hull drawings such as profile and general arrangement.
703 — Includes hull castings for stem, stern, port and rudder.
704 — Fresh water tanks, winches, and deck castings.
706 — Shell plating.
708 — Center line girders, vertical keel and bilge keel.
710 — Framing.
711 — Longitudinal girders (innercostals).
712 — Side stringers and breast hooks.
714 — Innerbottom plating.
715 — Deck plating.
717 — Bulkheads (transverse).
718 — Longitudinal bulkheads.
719 — Miscellaneous bulkheads between decks.
720 — Transverse and longitudinal engine casing bulkheads, casing top and fidley top.
724 — Hatches, doors, manholes, scuttles.
725 — Airports.
726 — Skylights and lifting gear.
730 — Shaft alley.
732 — Boiler foundations.
734 — Auxiliary machinery foundations in engine and boiler rooms.
740 — Fore and aft gangway and deck houses.
744 — Masts, booms and rigging.
750 — Arrangement of quarters.
752 — Refrigerator space and joiner work.
755 — Casing insulation.
756 — Sanitary bulkheads.
760 — Wood hatch covers (ceilings).
778 — Natural ventilation.
779 — Mechanical ventilation.
780 — Scuppers.
783 — Bitts and chocks.
785 — Anchor handling.
790 — Boat stowage, (boat davits, etc.).
791 — Crew's berths and metal lockers, galley and pantry equipment.
792 — Rail stanchions.
793 — Metal ladders.
794 — Carpentry shop; lamp and paint rooms; engineer's and bos'un's stores.
842 — Stern tube, shafting details.
844 — Ladders and gratings (engine and boiler rooms).
856 — Fireroom hoists, overhead cranes, etc.
900 — Steam and exhaust piping, (deck piping arrangement, etc.).
901 — Sea chests for ballast and sanitary pumps, etc.
905 — Sea chests for water circulating pumps, etc.
915 — Ventilating system, engine and boiler rooms.
918 — Sanitary fixtures.
920 — CO_2 fire extinguishing system.

stbd. — (Starboard — the plates so marked are for the starboard side of the ship.)

13/16 — (Size of the holes in the plate.)

C. K. O. S. — (Counter sink other side — referring to the holes.)

Roll up to sets — (Sets are templates for rolling a plate to proper curvatures.)

N. O. C. K. — (No counter sink.)

F. E. 30 — (This end of the plate fastens to frame number 30.)

Additional plate markings are shown in Table V, Standard Charge Numbers for Hull Drawings (As used by Sun Shipbuilding and Dry Dock Company.)

All of these marks are of importance in storing plates. Plates should be placed in separate rack compartments for each strake (Fig. 42-A). Each plate as lowered into the rack, should be placed close to the previous plate to prevent waste of space in the racks. Also, each plate should be extended out from the previous plate about three inches on the end, for identification purposes (Fig. 42-B). On this exposed end is placed marking needed to identify the plate, such as S. P. (shell plate), B6 (strake and number), P. or S. (Port or starboard), or UDK (upper deck) or PDK (poop deck).

Pulling Steel from Door

As previously explained, all material for a ship is placed at the "door" of the fabrication shop as it is fabricated. The ship erectors must remove materials from the door, erecting parts needed immediately, and storing remaining pieces.

Procedures used in pulling steel from the door are similar, irrespective of the particular piece being handled. Of course, methods of attaching lifting tackle vary with the shape of the piece.

In pulling steel from the door of the fabricating shop, two bars, several wooden wedges, two $\frac{3}{4}$" wire rope pennants, two shackles and shackle bolts, and also a marking pot with brush will be needed.

How to Pull Steel from the Shop Door

Procedure:

1. Raise edge of plate with bar. (See Fig. 7)
2. Place wooden wedges under plate. Slip the wooden wedge under the plate as it is raised until the shackle may be coupled to the plate.

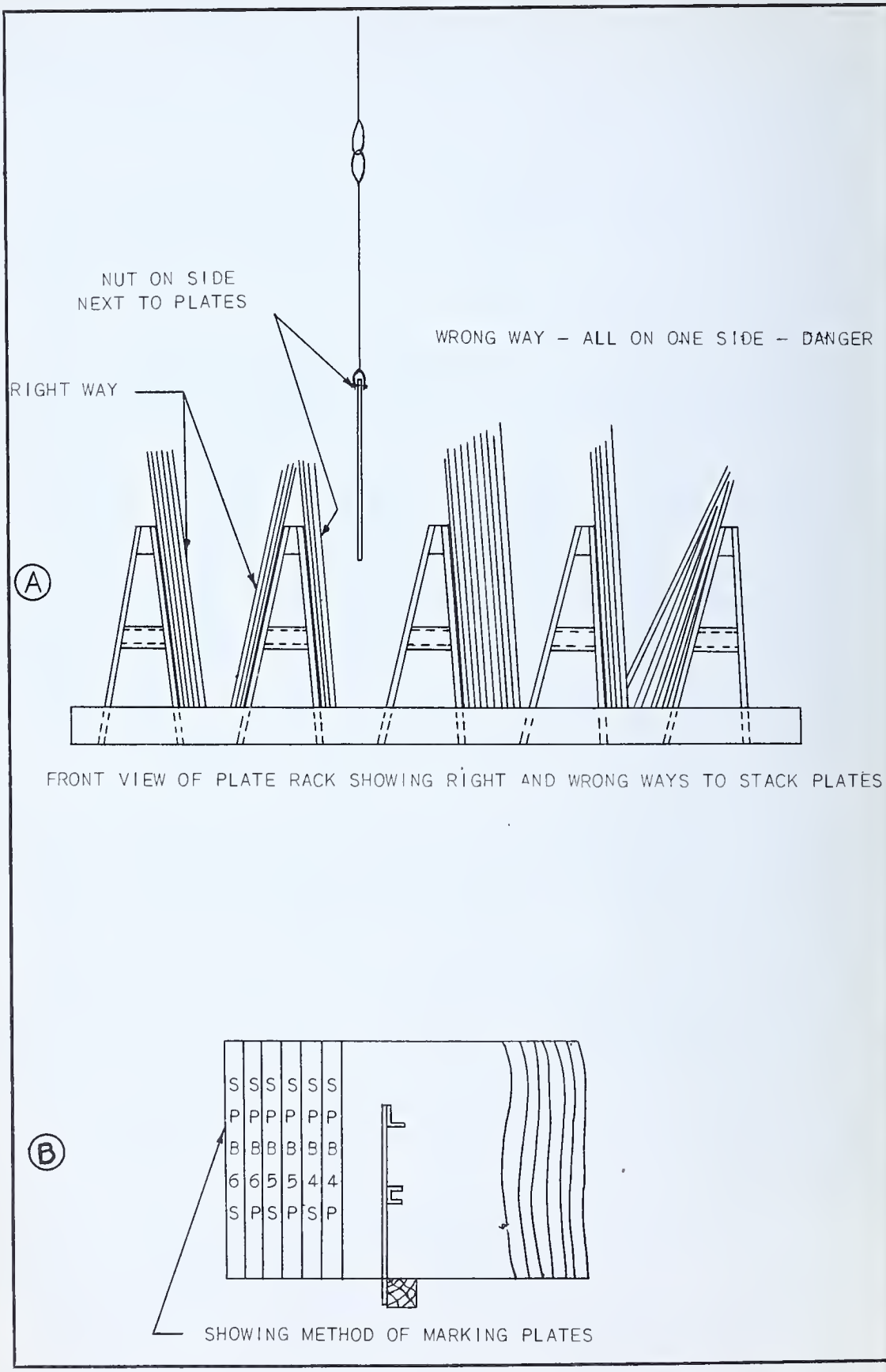

NUT ON SIDE
NEXT TO PLATES
WRONG WAY – ALL ON ONE SIDE – DANGER
RIGHT WAY
A
FRONT VIEW OF PLATE RACK SHOWING RIGHT AND WRONG WAYS TO STACK PLATES
B
S S S S S S
P P P P P P
B B B B B B
6 6 5 5 4 4
S P S P S P
SHOWING METHOD OF MARKING PLATES

FIG. 42 — *Side View of Plate Rack Showing Exposed Markings*

3. Couple shackles, connecting pennants and crane to plate.

   Always place both shackle bolts through the shackle and plate in the same direction. Shell plates should always be hooked to the top or outboard edge. When removed from the rack the plates will be hooked properly for erecting without the necessity of laying down the plate and rehooking. Upper deck plates, when racked, should be hooked to the inboard edge.

4. Hoist plate and transfer to storage location.

5. Lower plate into rack.

   When laying deck of the riveted type, the outboard plates are laid first then progressing inboard, so that as each plate is laid, the seam lap will be a top lap on the previous plate. As the plate is lowered into the rack make sure that the plate is turned so that the shackle bolts will be positioned with the nut next to the previous plate. See Fig. 38. Remove the nuts from the shackle bolts before slacking off with the crane. Space the plate so that three inches will extend on the end for marking, and then lower the plate into place.

6. Remove shackles.

   To unhook the piece it will be necessary to climb to the top of the rack where the shackles may be reached. If the shackle bolts bind in the holes, use the bar as in Fig. 43 to open the plates; this will release the bolt and it may be removed. Place the shackle bolt back in the shackle so that it will be available for the next job.

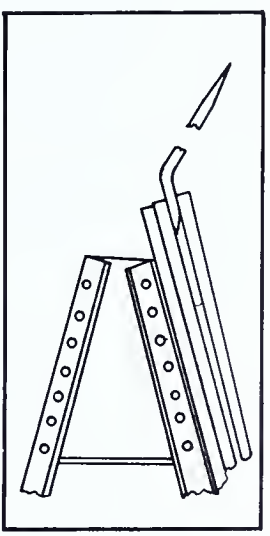


FIG. 43 — *Use of Bar to Free Shackle Bolts*

7. Mark identification on exposed edge of plate.

   Mark the plate on the extended end for identification with white paint by use of the marking brush.

Shaped or rolled plates are stacked on the ground, but should be separated into a port and starboard pile, placing the plates so that those to be used first will be on top. As each plate is laid on the pile, lay back about three inches from the last plate to allow a space for identification markings. Mark plainly with the marking paint.

Storing House Bulkheads

The house bulkheads are to be separated according to the job to which they belong: e. g., (719-1) forecastle houses, (719-2) bridge houses, (719-3) poop house, (740-) navigation bridge and pilot houses. Each of these should be stored in a separate place, since each is an individual job. If they are mixed together extra work will be required in removal.

Storing Shell Frames

Shell frames each have a number. The numbering of the frames may start at either end of the ship and progress numerically to the other end. Numbering usually starts at the after end of the ship, although in some cases it may start at the forward end. The lower numbered frames No. 1, 2, 3, 4, 5, 6, etc.), will therefore be used at the after end of the ship, and should *not* be stored with frames numbered 60, 61, 62, etc. Neither should the higher numbers be stored with the lower numbers, since the high numbers are for the forward end of the ship.

Frames should be handled carefully to prevent bending while hooking up and while storing. They should be blocked up so the weight is evenly distributed. If another load is landed on top the first, blocking should be placed on top of the first pile, directly over the blocking used under the first pile. (Fig. 44)

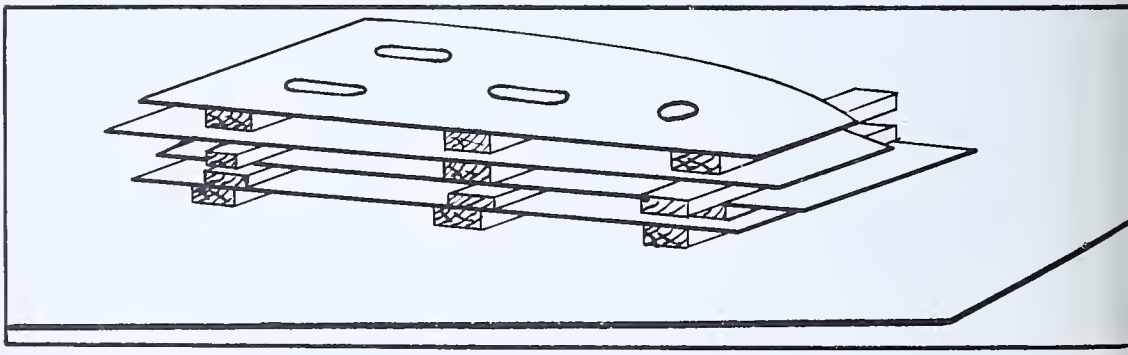


Fig. 44 — *Blocks Placed Directly Over Each Other to Prevent Bending of Stored Steel*

Storing Brackets

Loose brackets should be kept in one place when possible; this prevents their becoming lost, and makes sorting easier. When small loose brackets are handled, a box (dump box) should be used, since small brackets cannot be hooked to the crane safely. Larger brackets when piled evenly may be

hooked on by passing the pennants around the pile of brackets. Make the pennants cross each other at the top, and shackle the end of each pennant to the opposite pennant. Loads of brackets hooked in this manner may be safely moved into tanks.

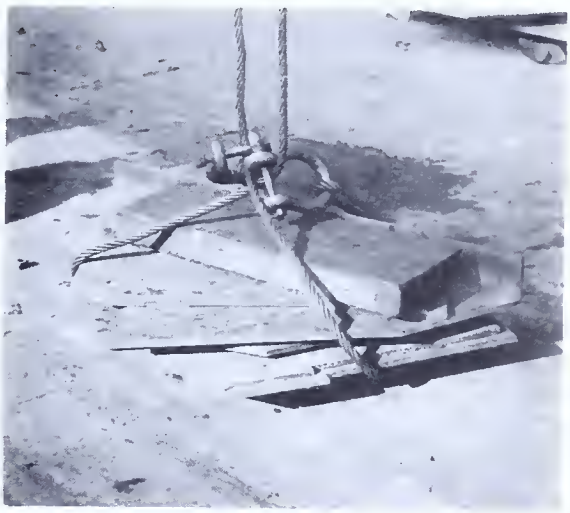


FIG. 45 — *Hook-up of Triangular Brackets*

STORING LINERS

Shell liners are stored in some convenient place where they may be sorted into piles containing the proper number required in one tank or hold space. The pile will be handled by passing the pennants around the pile and shackling to the pennants. (Fig. 46)

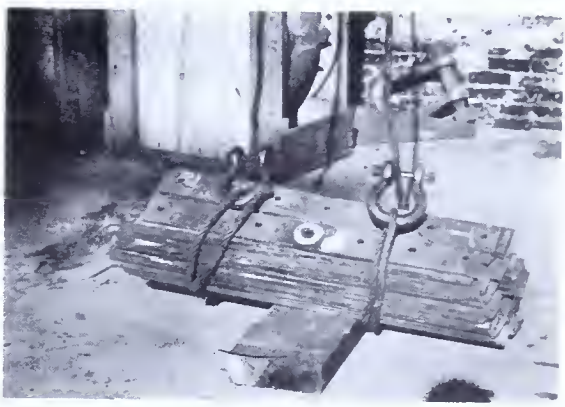


FIG. 46 — *Hook-up of Liners*

STORING DECK SECTIONS

Deck sections should be stacked carefully since they become bent and damaged if improperly stored. The first section placed upon the ground should be blocked evenly so that the weight is well supported. (Fig. 47) Each section placed on top should be placed so the flanged plate stiffeners on the under side of the deck come directly over top of the stiffeners on the previous section. If the stiffeners are not spaced the same, blocking should be placed to support the place where the stiffeners do not meet. Deck sections of this size are hoisted by using four hook pennants of 1¼" wire rope.

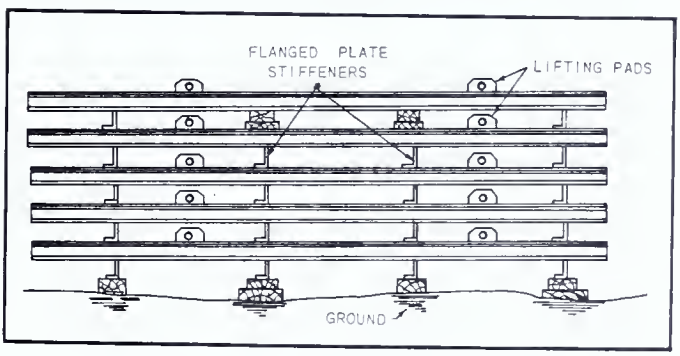


FIG. 47 — *Stacking Deck Sections*

QUESTIONS

1. Why is it necessary to handle and store material?
2. How should we hook up a shell plate for handling?
3. What is the proper method of racking shell plates for storage?
4. How are large tanker bulkheads handled:
5. How are they stored?
6. Why should small house bulkheads be stored in separate places, according to the job on which they are to be used?
7. How should piles of deck sections or frames be stored and blocked to prevent unnecessary bending?

Part VI

RIGGING PRACTICE AN ERECTOR MUST KNOW

Erection work which can not be done with cranes requires that rigging procedures be used. Equipment used in rigging includes rope falls, chain hoists, cables, and a winch to furnish power.

Chain hoists are used in handling loads in close quarters or for loads which are too heavy to be handled by using a rope fall. Typical jobs for which the chain hoist is used include erecting foundations, bilge plates, dry-dock work (bottom plates), hawse pipes, ventilators and interior bulkheads. The sizes of chain hoists most frequently used for these jobs are one, two, and three ton; however, larger hoists are available if needed.

Chain hoists are hung by the use of chokers, shackles, lashing, "C" clamps, or by a combination of these fastenings.

Chokers are wire ropes with an eye spliced in each end. They are made from different sizes of wire rope in order to handle a range of loads safely. When chokers are used to hang chain hoists they are placed around a convenient beam, channel, or other means of support.

A chain hoist is hung by means of shackles to a conveniently located beam, channel, or plate near the job to be done, and in a position that will allow the greatest ease in handling. Beam clamps and "C" clamps of various designs are used to attach shackles to beams for hanging chain hoists.

Lashing a chain hoist is done by wrapping a number of turns of manila rope around a beam, or other suitable fixed member, and hooking the hoist into these loops. In hooking to a lashing, be sure that each loop will support part of the load. Rope slings may be used for lashing light loads.

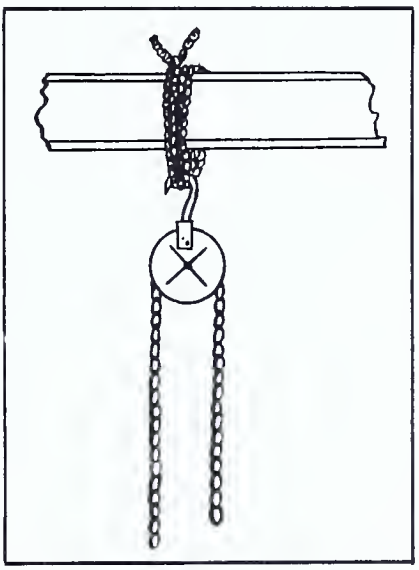


FIG. 48 — *Lashing a Chain Hoist*

SAFETY PRECAUTIONS

Necessary safety precautions should be taken when hanging chain hoists. Ascertain that the hoist is hung to a solid member of sufficient strength to

hold the load to which it will be subjected. See that the lashing, choker, sling, shackle or clamp used is of sufficient strength to safely hold the load. *Use a chain hoist of the correct capacity;* do not use a one-ton hoist for a two-ton job. Be sure that rope slings and chokers are lashed so that sharp edges of beams or channels will not cut them.

The "A" frame shown in Fig. 49 is used on jobs where a means of supporting an object under the deck is necessary without holding a crane from other service.

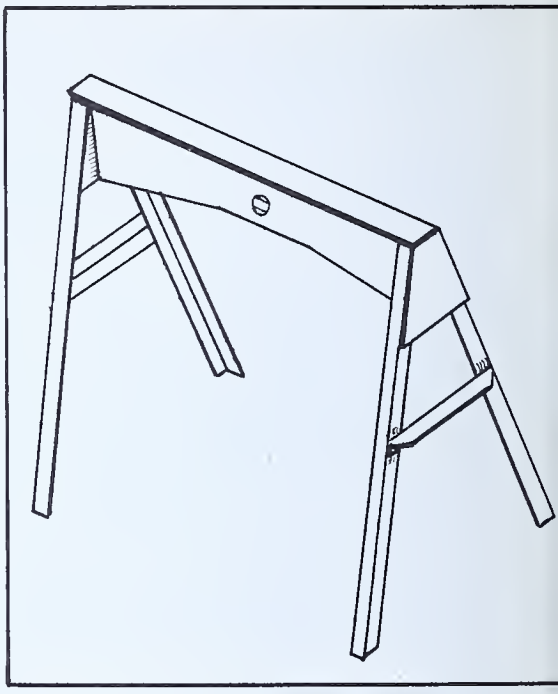


FIG. 49 — *"A" Frame*

Knots and Slings

WHIPPING ROPE END

In whipping a rope, the end of the twine is placed in the depression between two of the strands and one or two turns made around the rope to hold it in place. Then the main part of the yarn "a", (Fig. 50) is laid lengthwise along the rope, forming a long loop, one part of which, "b", is held tight and wound around both the rope and the yarn until a sufficient number of turns have been made. Then, by pulling the end "c", until the loop is pulled tightly under the whipping, the whole is made tight and secure. The ends may then be cut off close to the rope.

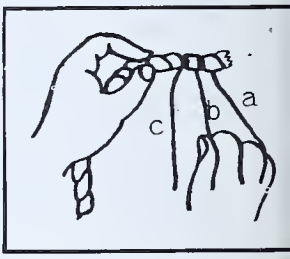


FIG. 50 — *Whipping Rope End*

SIMPLE BOWLINE KNOT

This knot is used where a loop which will not slip or pull tight is required. To make this knot, first lay the free end of the rope over the standing part, forming a loop or bight. See Fig. 51. Then bring the free end of the rope up through the bight, leading the end around the standing part, and then down through the bight again.

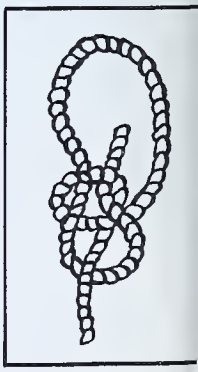


FIG. 51 — *Simple Bowlin Knot*

Bowline on a Bight, or Double Bowline

This bowline is used when a loop is desired in the middle of a rope. It is especially useful for forming a seat for men or in lifting materials. See Fig. 52. To tie this bowline, take the bight of the rope and proceed the same as with the simple bowline. However, instead of tucking the end down through the bight of the knot, carry the bight over the whole and draw up, thus leaving it double in the knot and double in the standing part. The loop under the standing part is single.

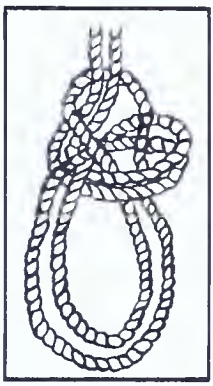


Fig. 52 — *Bowline on a Bight or Double Bowline*

Running Bowline

This serves as an excellent slip knot; it slips freely and cannot jam or unfasten. It is actually a simple bowline with the long end or standing part of the rope passed through the large loop. See Fig. 53.

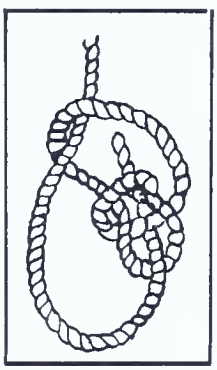


Fig. 53 — *Running Bowline*

Clove Hitch

A clove hitch is used to fasten a rope at right angles to a spar, and also at the beginning of a lashing. When used for securing guys, shear legs, etc., the knot should be made with a long end, which is formed into two half hitches around the standing part and then seized to it. If no free end of the rope is available, make a hitch as shown in Fig. 54, slipping it over the end of the timber.

Figure Eight Knot

This knot is used to prevent unreeving or to prevent the end of a rope slipping through a block. It is made from a loop by passing the free end of the rope around the standing part in a second loop and then back through the first loop. See Fig. 55.

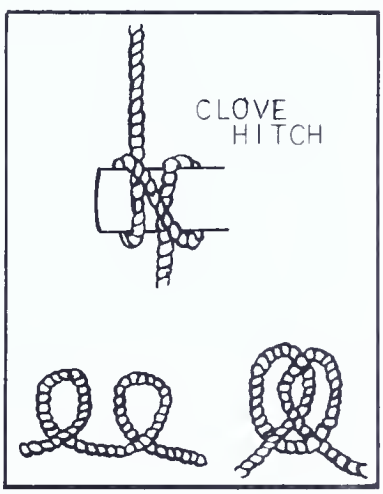


Fig. 54 — *Making a Clove Hitch*

Reef Knot

This is commonly used to join two ropes of the same size. A reef knot is strong; the harder the pull the more firmly it holds. However, a reef knot joining two ropes of unequal sizes is

likely to slip. It is easily tied by passing the standing and running parts of each rope through the loop of the other in the same direction; i. e., from above downward, or vice versa. See Fig. 56. A reef knot may be upset by pulling the standing and running parts of the same piece of rope in opposite directions.

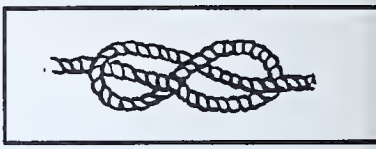


Fig. 55 — *Figure Eight Knot*

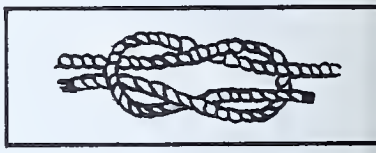


Fig. 56 — *Reef Knot*

Overhand Knot

This is used at the end of a rope to prevent it from unreeving or to prevent the end of a rope slipping through a block. It is tied by making a loop of the rope with the short end of the rope passing behind the long end. See Fig. 57. The short end is passed over the main rope down through the loop. The knot is then pulled tight. The objection to this knot is that it is difficult to untie.

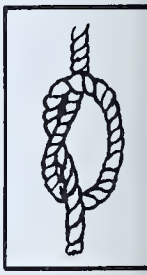


Fig. 57 — *Overhand Knot*

Round Turn With Double Half Hitch

This is used for belaying or making fast the end of the rope around its own standing part. The end may be seized to the standing part to prevent slipping. This knot should never be used for hoisting a spar. Fig. 58 shows a round turn in connection with the double half hitch.

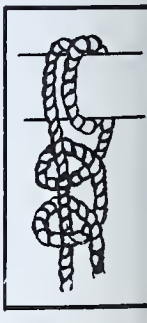


Fig. 58 — *Round Turn With Double Half Hitch*

Scaffold Hitch

This is used for slinging scaffold so that it will not turn in the sling. It is started by making a clove hitch with the two free ends of the rope below the scaffold. See Fig. 59. Then, each rope is drawn back on itself and up over the opposite sides of the board, where the short end is joined to the other with a bowline knot. Another way of making the hitch is to wrap the rope around the scaffold plank so that it crosses the top of the plank three times. The middle loop is then pulled down so that it folds over the end of the plank. This hitch is completed by attaching the free end of the rope to the standing part with a bowline knot.

Timber Hitch

This is used for hauling and lifting spars, boards, and timbers. It forms a secure temporary fastening which may be easily undone. It is similar to the

half hitch but is more secure. Instead of the end being passed under the standing part of the rope once, it is wound around the standing part three or four times, as shown in Fig. 60.

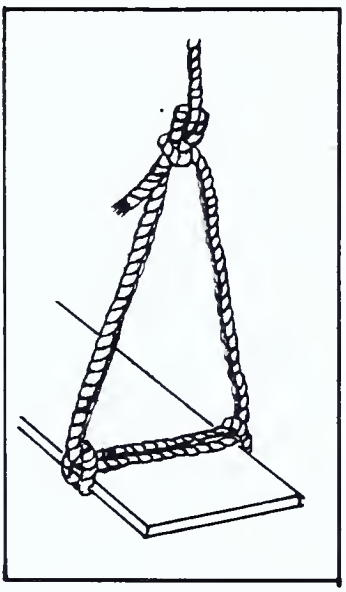


FIG. 59 — *Scaffold Hitch*

EFFICIENCY OF VARIOUS HITCHES AND KNOTS

The size of the rope used is determined by the size of the job to be done. In Table I the safe working load of different size rope is stated. However, the percentage of efficiency drops quickly when a knot is tied in a line. The table shown below gives the different percentages of efficiency when rope is used with splices and knots.

TABLE VI — DECREASE OF STRENGTH OF ROPE WHEN KNOTTED OR SPLICED

Full strength of dry rope	100 per cent efficiency
Eye splice over iron thimble	90 per cent efficiency
Short splice in rope	80 per cent efficiency
Timber hitch, round turn, half hitch	65 per cent efficiency
Bowline, slip knot, clove hitch	60 per cent efficiency
Square knot, weaver's knot, sheet bend	50 per cent efficiency
Flemish eye, overhand knot	45 per cent efficiency

FIG. 60 — *Timber Hitch*

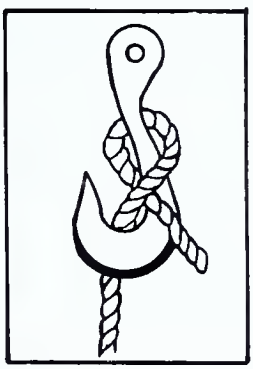


FIG. 61 — *Blackwall Hitch—Single*

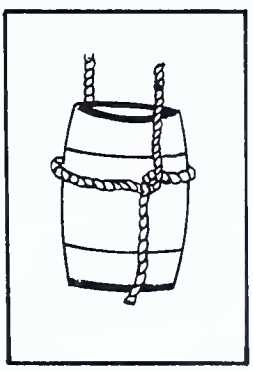


FIG. 62 — *Barrel Sling Vertical*

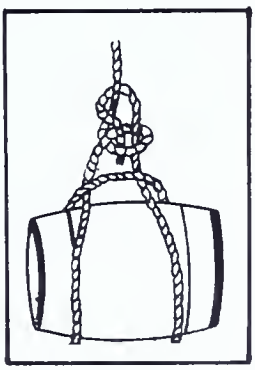


FIG. 63 — *Barrel Sling Horizontal*

BLACKWALL HITCH — SINGLE

The blackwall hitch is used for attaching a single rope to the hook of a block. It consists of a loop with the free end of the rope passing under the

standing part and across the hook. See Fig. 61. This hitch will carry a heavy load, providing the tension is constant.

Barrel Hitch or Sling

This hitch is used for hoisting barrels in either a vertical or horizontal position. It is similar to a running bowline. To sling a barrel vertically, make an overhand knot on top of the two parts of the rope, open out the knot and slip each half down the sides of the barrel and secure them with a bowline. See Fig. 62. To sling a barrel horizontally, the bowline is made with a long bight. See Fig. 63.

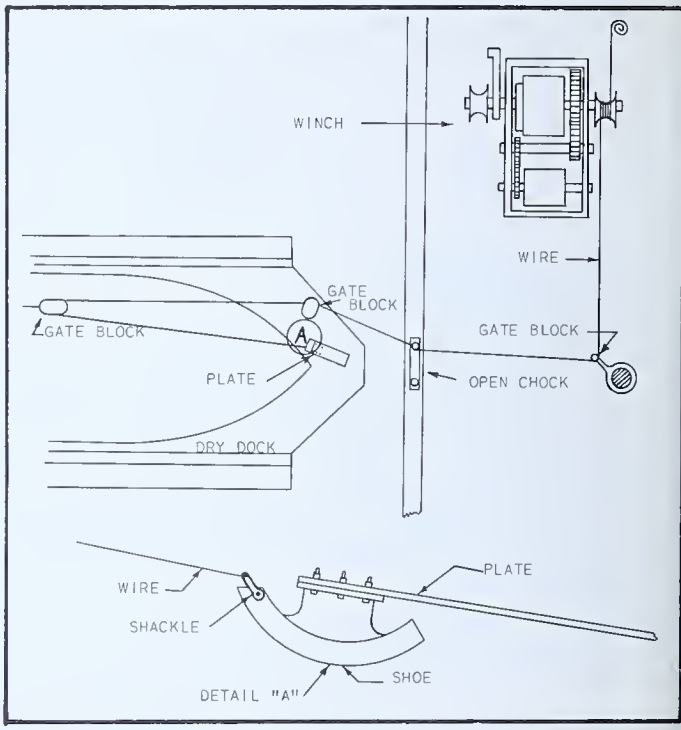


Fig. 64 — *Rigging Used to Pull Plate Using a Gate Block*

Gate Blocks, and Wire Rope

A gate block opens at one side, making it easy to thread the block without running the end of the wire rope through the block. The block is locked in a closed position by a patent catch.

The gate block and wire rope rigging are largely used for dry dock repair work. Fig. 64 illustrates the rigging used for pulling plates under the ship when replacing bottom plates.

Power is obtained by wrapping from five to seven turns on the niggerhead of the winch and pulling on the loose end. See Fig. 64. The wire is wrapped around the niggerhead so that it leads off the top. When the winch head is rotated, pull the slack end of the wire tightly to the head, thus causing the wire to be pulled by the winch.

QUESTIONS

1. **Where does the erector use rigging?**
2. **What is a lashing?**
3. **List several knots used by an erector. Make a sketch of each knot.**
4. **List several methods of hanging a chain block.**
5. **What is a gate block?**
6. **What is a shell wire?**

Part VII
LEVELING AND PLUMBING

Declivity

The slope of the shipway (that is, of the sliding surface) is called the declivity. This is expressed in inches per horizontal foot, as shown in Fig. 65. The rate of rise of the line "ab" is such that for every foot along the level "bc" the vertical rise of the sloping line is 5/8", or "ac". Declivity of shipways varies in different yards. In the Sun yard, shipways No. 1, No. 2, No. 8, and No. 9–No. 20 inclusive, have a declivity of 5/8" per foot. Shipways No. 3, No. 4, No. 5, No. 6 and No. 7 have a declivity of 11/16" per foot.

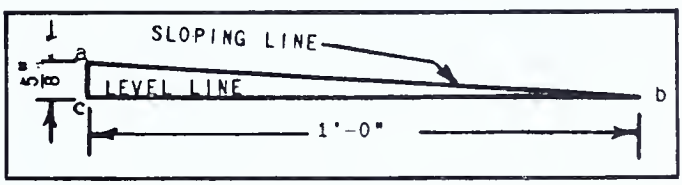


Fig. 65 — *Declivity of Shipways*

Usually the bottom of the ship's keel is parallel to the base line (although this is not always true). The tops of the keel blocks when set up must all be on a line which has the same declivity as the ways themselves. The base line and all of the water lines will then be parallel to the line of the keel blocks, and will have this same declivity, while the frame lines of the ship will be at right angles to the base line. These conditions are illustrated in Fig. 66, which also shows how levels, declivity boards, and plumb lines are used to keep bulkheads and other assemblies correctly aligned when erecting and regulating the ship.

Use of Declivity Board

A declivity board is an accurately planed board whose two opposite edges are not parallel, but form an angle equal to that of the slope of the shipway. When the top edge of the board is made horizontal by means of an ordinary carpenter's level, as shown at "a" in Fig. 66, the bottom edge of the board will slope down at the proper rate and can be used to test the declivity of water lines, base line, etc., in a fore and aft direction. A declivity board is not used when testing water lines transversely, since there is no slope in that direction.

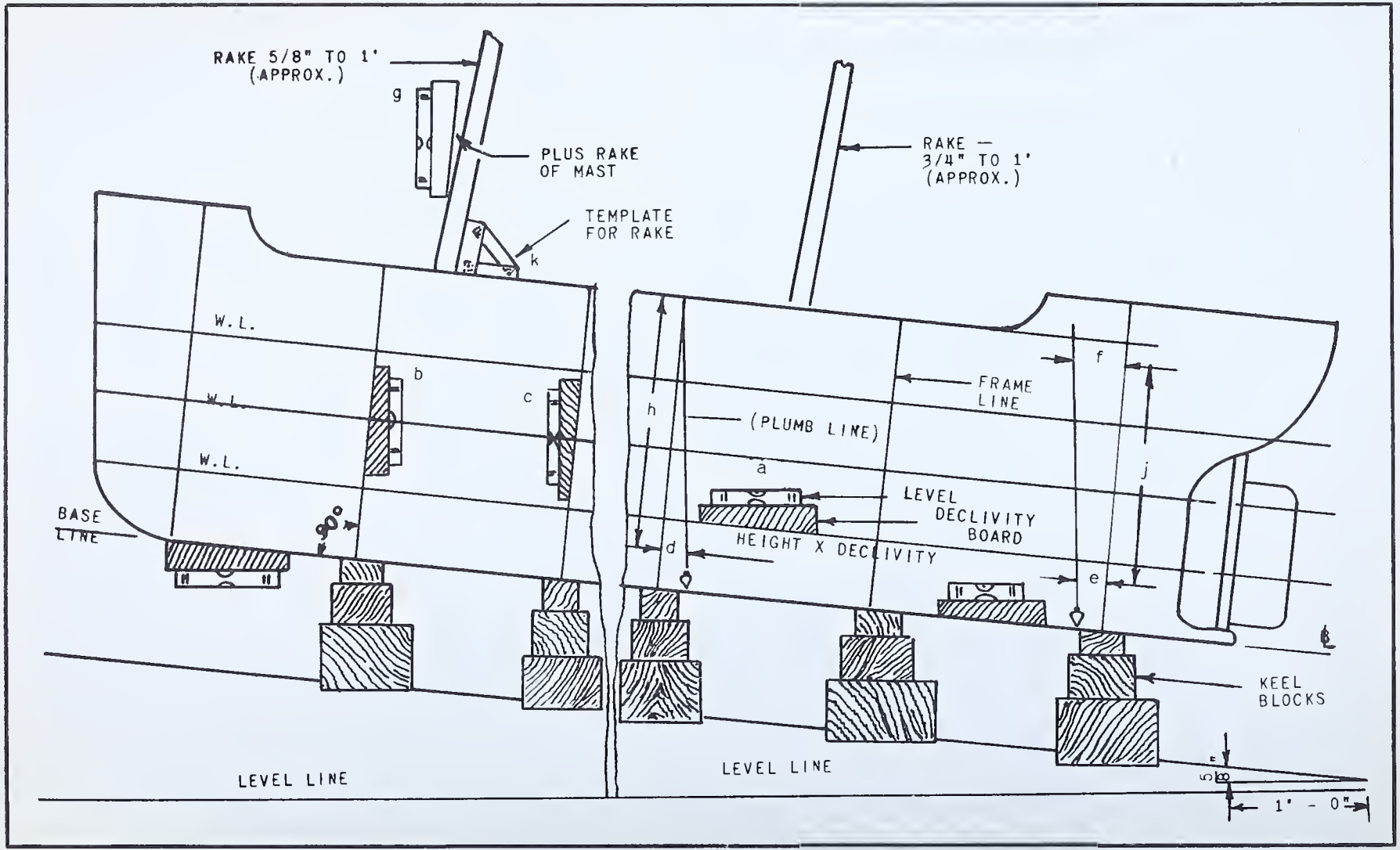


FIG. 66 — *Leveling and Plumbing of Ship During Construction*

Frame lines and transverse bulkheads are perpendicular to the base line, permitting declivity to be tried as shown at "b" in Fig. 66, using the level in its vertical position. By turning the declivity board end for end, the forward side of the bulkhead may be tried as shown at "c".

Since a ship on the ways has declivity in the longitudinal (fore and aft) direction only, it is imperative that the level be held parallel to the center-line of the ship when used with a declivity board. When used for transverse leveling, no declivity board is used and the level must then be held at right angles to the center line; that is, parallel to the frame lines.

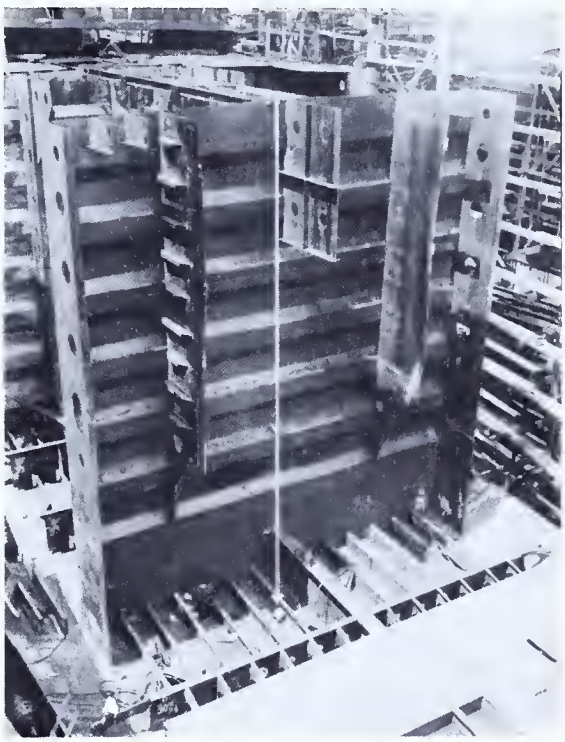


FIG. 67 — *Plumbing the Center Section of Transverse Bulkhead*

USE OF PLUMB BOB AND LINE

Another and more accurate method of testing the declivity of a transverse bulkhead is by means of a plumb line and bob as at "d" in Fig. 66. The plumb line can be hung at the after side of the bulkhead (near a vertical stiffener if possible) and the vertical height "h" measured from the top to where the measurement "d" is taken. This height (in feet) multiplied by the declivity (in inches per foot) gives the required dimension "d" in inches. This dimension is measured from the bulkhead to the plumb line and at *right angles to the bulkhead.* If "d" when measured is too large, the bulkhead must be rocked forward (taking for granted that the bulkhead is set properly at the bottom).

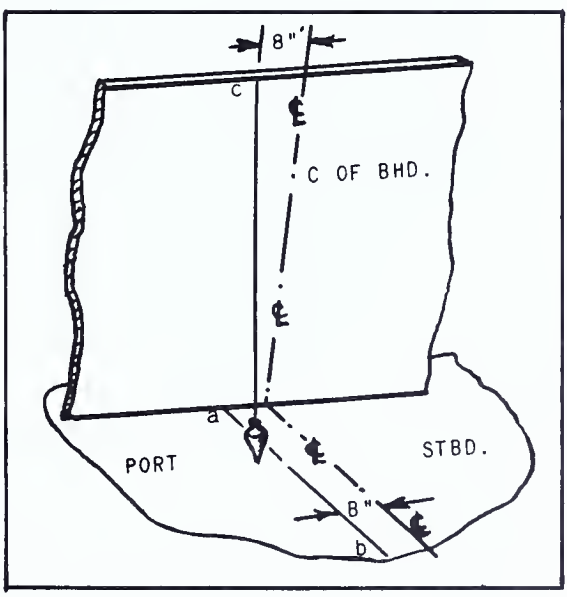


FIG. 68 — *Plumbing a Bulkhead Transversely*

If for any reason it is not convenient to hang the plumb line on the after side of the bulkhead, it can be arranged as shown at "e" and "f" in Fig. 66. The plumb line is hung forward of the bulkhead from any available support, and the distances "f" and "e" are measured at two points whose difference in height is the distance "j". Then if the bulkhead is plumbed properly, "f-e" (in inches) is equal to "j" (in feet) multiplied by the declivity.

Fig. 67 shows a plumb bob hanging in such a way as to show whether a transverse bulkhead is leaning to port or starboard. The plumb line (Fig. 68) is hung at any given distance from the centerline at the top of the bulkhead. A line "ab" is marked on the tank top at the same distance from the center line of the ship. If the bulkhead is plumb transversely, the plumb bob will hang exactly over this line "ab", otherwise the bulkhead must be rocked to one side or the other.

QUESTIONS

1. **Why is a ship built on a shipway having declivity?**
2. **How is the rate of declivity expressed?**
3. **What are the common declivities used in the shipyard?**
4. **How is a declivity board used to true a section with a spirit level?**
5. **How does declivity affect the methods used by an erector?**

Part VIII
PROCEDURES IN SHIP ERECTION

As a result of long experience, shipyards have evolved procedures or sequences for erecting various types of ship hulls. Although these procedures may vary in minor details, the erection of a specific type of vessel is quite similar, irrespective of the shipyard in which it is being erected. This sequence of hull erection is shown in Table VII.

The ship erection job sheets, presented in Part VIII, are representative of typical jobs essential to the erection of a type T2-SE-A1 Welded tanker. See Tables VIII and IX. A profile view of this vessel is shown on the frontispiece.

In addition to presenting specific procedures for erecting the welded steel tanker described, these job sheets are largely representative of the procedures of erection on many types of ships.

TABLE VII
ERECTING PROCEDURE
Type T2-SE-A1 Welded Tanker

Tanks No. 5, 6, 7, and 8

1. Flat and vertical keel sections 47 to 71 (inclusive plt. No. 8, 9, 10, 11, 12, 13, 14, and 15, Flat keel No. 7 and 16.
2. Shell bottom sections 56 to 59 P/S
3. Shell bottom sections 53 to 56 P/S
4. Shell bottom sections 59 to 62 P/S
5. Shell bottom sections 50 to 53 P/S
6. Lay out shell plates D 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13 P/S
7. Center tank transverse bhd. No. 56
8. Center tank transverse bhd. No. 59
9. Center tank transverse bhd. No. 53
10. Center tank transverse bhd. No. 62
11. Center tank transverse bhd. No. 50
12. Loose brackets 50 to 62 P/S
13. Center line upper deck girder assembly 56 to 59
14. Center line upper deck girder assembly 53 to 56
15. Center line upper deck girder assembly 59 to 62
16. Center line upper deck girder assembly 50 to 53
17. Longitudinal bulkhead assembly 56 to 59 P/S
18. Longitudinal bulkhead assembly 53 to 56 P/S
19. Longitudinal bulkhead assembly 59 to 62 P/S
20. Longitudinal bulkhead assembly 50 to 53 P/S
21. Bilge assembly sections 56 to 59 P/S
22. Transverse wing bhds 56 P/S
23. Transverse wing bhds 59 P/S

TABLE VII
ERECTING PROCEDURE
(Continued)

24. Side shell assembly 56 to 59 P/S
25. Tie beams 57 and 58 P/S
26. Bilge assembly section 53 to 56 P/S
27. Transverse wing bhd. 53 P/S
28. Side shell assembly 53 to 56 P/S
29. Tie beams 54 and 55 P/S
30. Bilge assembly section 59 to 62 P/S
31. Transverse wing bhd. 62 P/S
32. Side shell assembly 59 to 62 P/S
33. Tie beams 60 and 61 P/S
34. Bilge assembly section 50 to 53 P/S
35. Transverse wing bhd. 50 P/S
36. Side shell assembly 50 to 53 P/S
37. Tie beams 51 and 52 P/S
38. Upper deck sections 56 to 59 P/S
39. Upper deck sections 53 to 56 P/S
40. Upper deck sections 59 to 62 P/S
41. Upper deck sections 50 to 53 P/S
42. All tank ladders 50 to 62 P/S
43. Erect D plates No. 8, 9, 10, 11, 12, and 13 P/S

No. 9 Tank Section

44. Shell bottom sections 47 to 50 P/S
45. Center tank transverse bhd 47
46. Loose brackets 47 to 50 P/S
47. Center line deck girder assembly 47 to 50
48. Longitudinal bhd assembly 47 to 50 P/S
49. Bilge assembly, build up 47 to 50 P/S
50. Wing cofferdam bhds. 46 and 47 P/S
51. Side shell assembly 47 to 50 P/S
52. Tie beams 48 and 49 P/S and bracket AAK (715-1-3) P/S
53. Upper deck sections 47 to 50 P/S

Engine Room and Stern Section

54. Flat keel plates No. 17, 18, and 19
55. Shell plates A 16, 17, and 18 P/S
56. Shell plates B 16, 17, and 18 P/S
57. Shell plates C 17, and 18 P/S
58. Center line vertical keel and shell longitudes 45 to 47 P/S
59. Double bottom sections 40 to 45
60. Double bottom sections 31 to 40
61. Flat keel No. 20 and stern frame assembly
62. Transverse bhd No. 45 center tank
63. Flat 16′-3″ above base line 45 to 46
64. Transverse bhd 7′ aft of bhd 47
65. Longitudinal bhds 36 to 46 P/S
66. Transverse wing bhds 36 P/S
67. Shell frames 41 and 45 — Shell longitudes 36 to 46 assembly — generator flat to bilge P/S
68. Generator flat, O. B. section 36 to 46 P/S
69. Shell frames and longitude assembly 36 to 46 generator flat to upper deck P/S
70. Boiler room deck 36 to 47 P/S
71. Upper deck sections 41 to 46 P/S and CL
72. Double bottom sections 27 to 31
73. Double bottom sections 17 to 27
74. Double bottom sections 9 to 17
75. Transverse bhds at No. 25 — tank top to generator flat
76. Web frames with shell longitudes assembly 25 to 36 P/S
77. Web frames with shell longitudes assembly 17 to 25 P/S
78. Afterpeak bhd No. 9
79. All engine room stanchions
80. Generator flats and boiler room flats, 36 to 9 P/S (with distilled water tank)
81. Afterpeak frames 6, 7, and 8 with ammunition flat

TABLE VII

ERECTING PROCEDURE

(Continued)

82. Steering gear flat
83. Frames 10 to 16 with stringer
84. Shell plates A 19, SK 1, SK 2, A 20, B 19, A 21, B 20, B 21, C 19, C 20, C 21, D 14, D 15, D 16, D 17, D 18, D 19, D 20, C 22, C 23, C 24 P/S
85. Shell plates H 15, H 16, H 17, E 19, E 20, E 21, E 22, G 15, G 16, G 17, G 18, G 19, F 15, F 16, F 17, F 18, F 19 P/S
86. Web frames and shell longitude assemblies 9 to 31 P/S (generator flat to upper deck)
87. Transverse bhd 31 (generator flat to upper deck)
88. Stanchions generator flat to upper deck
89. Upper deck sections 31 to 41 P/S
90. Upper deck sections 18 to 31 P/S
91. Upper deck sections 9 to 18 P/S
92. Web frames CL and D P/S (steering gear flat to upper deck)
93. Upper deck sections 9 to stern
94. Shell frames 9 to stern P/S (steering gear flat to poop deck)
95. Shell plates K 15, K 16, K 17, K 18, H 18, F 20, G 20, G 21, H 19, H 20, H 21, J 15, J 16, J 17, J 18, J 19, J 20 J 21, K 19, K 20, K 21, K 22 P/S
96. Shell longitudes L 1, 2, 3, 4, and 5 P/S (31 to 36)
97. Engine and boiler room casings
98. Transverse and longitude poop house bhds.
99. Shell frames 45 to stern P/S (upper deck to poop deck)
100. Poop deck sections 45 to stern P/S
101. Shell plates M 9, 10, 11, 12, 13, 14, 15, 16 P/S, N 9, 10, 11, 12, 13, 14, 15, 16 P/S
102. All loose brackets throughout engine room and stern, coaming plates and bulwark bars.

Tanks No. 4, 3, 2, and 1

103. Shell bottom sections 62 to 65 P/S
104. Shell bottom sections 65 to 68 P/S
105. Shell bottom sections 68 to 71 P/S
106. Center tank transverse bhd. 65
107. Center tank transverse bhd. 68
108. Center tank transverse bhd. 71
109. Loose brackets 62 to 65 P/S
110. Loose brackets 65 to 68 P/S
111. Loose brackets 68 to 71 P/S
112. Center line upper deck girder 62 to 65
113. Center line upper deck girder 65 to 68
114. Center line upper deck girder 68 to 71
115. Longitudinal bulkhead 62 to 65 P/S
116. Bilge section assembly 62 to 65 P/S
117. Wing tank transverse bhd. 65 P/S
118. Side shell section assembly 62 to 65 P/S
119. Tie beams 63 and 64 P/S
120. Longitudinal bulkhead 65 to 68 P/S
121. Bilge section assembly 65 to 68 P/S
122. Wing tank transverse bhd. 68 P/S
123. Side shell sections 65 to 68 P/S
124. Tie beams 66 and 67 P/S
125. Longitudinal bhds. 68 to 71 P/S
126. Bilge section assembly 68 to 71 P/S (build up)
127. Wing tank transverse bhd. 71 P/S
128. Side shell sections 68 to 71 P/S
129. Tie beams 69 to 70 P/S
130. Upper deck sections 62 to 65 P/S
131. Upper deck sections 65 to 68 P/S
132. Upper deck sections 68 to 71 P/S
133. Shell bottom sections 71 to 76 P/S
134. Flat keel plates No. 6, 5, 4, and 3
135. Shell Plates A 5, 4, 3, B 5, 4, D 7, 6, 5, 4, 3, 2 P/S

TABLE VII
ERECTING PROCEDURE
(Continued)

136. Center line bulkhead 71 to 73
137. Longitudinal swash bhd. 71 to 73 P/S
138. One half 73 trans. bhd.
139. Other half 73 trans. bhd.
140. One half 75 trans. bhd..
141. Other half 75 trans. bhd.
142. Side shell sections 71 to 73 P/S
143. Loose brackets P/S
144. Upper deck sections 71 to 73 P/S
145. Bilge keel, cargo tank ladders

Midship Deck House

146. Side frames No. 61, 62, 63, shell longitudes, shell plates, bulwark bars assembly P/S
147. Water tanks under bridge deck P/S
148. Bridge house front bhds. (upper deck to bridge deck)
149. Bridge house after bhds. (upper deck to bridge deck)
150. Bridge deck section assembly
151. Bridge deck house bhds. P/S
152. Upper bridge deck section
153. Upper bridge deck house bhds. P/S
154. Navigation bridge deck section
155. Pilot house assembly
156. Navigation wings and stanchions P/S
157. Bulwark bars, coaming plates and brackets P/S

Forward Section to Stem

158. Forward pump room bottom, (double bottom section) 75 to 77
159. Transverse bhd. 77 Star.
160. Longitudinal center line bulkhead 77 to 89
161. Transverse bhd. 77 port
162. Floors 78 to 88 P/S
163. Intercostals 77 to 89 P/S
164. Web frame 78, 81, and 85, shell longitude assembly 75 to 89 P/S
165. Transverse bhd. 89 (bottom to ammunition trunk)
166. Ammunition trunk
167. Second deck sections 75 to 89
168. Shell plate A 2 P/S
169. Floors and c intercostals 89 to 104
170. Center line swash bhd. 89 fwd. to 104
171. Shell frames and longitude assembly 89 to 104 P/S (build up)
172. Second deck section 89 to 104
173. Shell plates H 4, 3, B 3, 2, C 5, 4, 3, 2, G 4, 3, E 6, 5, 4, 3, F 4, 3, 2, P/S
174. Transverse bhd. 76 (Second deck to upper deck)
175. Shell long and web frame assembly 75 to 89 P/S
176. Shell long and web frame assembly 89 to 104 P/S
177. Transverse bhd. 89 (second deck to upper deck)
178. Chain locker assembly
179. Stanchions (second deck to upper deck)
180. Upper deck section assemblies 73 to 104
181. Shell plates K 4, 3, J 4, 3 P/S
182. Stem section
183. Forecastle house bulkheads (upper deck to forecastle deck)
184. Shell frames and longitude assemblies 84 to 107 P/S
185. Forecastle deck sections
186. Shell plates M 2, 3, 4, 5, 5½, N 2, 3, 4 P/S
187. Bulwark bars, brackets, and half round P/S
188. Fore and aft gang way
189. Cargo hatches, ladders
190. Clean up all odd jobs
191. Engine room and pump room foundations
192. Degausing belt and gun foundations

TABLE VIII

HULL ERECTION ASSEMBLIES AND RELATED JOB SHEETS

Assemblies to be Erected (From Table VII)	Job Sheets Presenting Erection Procedures (From Table IX)
1	No. 1 and 2
2, 3, 4. 5, 44, 103, 104, 105	No. 3
7, 8, 9, 10, 11, 45, 106, 107, 108	No. 4
13, 14, 15, 16, 47, 112, 113, 114	No. 5
12, 46, 109, 110, 111	No. 6
17, 18, 19, 20, 48, 115, 120, 125	No. 7
21, 26, 30, 34, 49, 116, 121, 126	No. 8
22, 27, 31, 35, 50, 117, 122, 127	No. 9
24, 28, 32, 36, 51, 118, 123, 128, 142	No. 10
25, 29, 33, 37, 52, 119, 124, 129	No. 11
38, 39, 40, 41, 53, 130, 131, 132, 144	No. 12
54, 55, 56, 57	No. 13
59, 60, 72, 73, 74, 158	No. 14
61	No. 15
79, 88	No. 16
76, 77, 86, 92, 164, 175, 176, 184	No. 17
82	No. 18
68, 70, 80	No. 19
97	No. 20
84, 85, 95, 101, 135, 173, 181, 186	No. 21
98, 148, 149, 151, 153, 183	No. 22
100, 150, 152, 154, 185	No. 23
138, 139, 140, 141	No. 24
158	No. 25
169	No. 26
81, 165, 166	No. 27
178	No. 28
182	No. 29
190	No. 30

TABLE IX

SEQUENCE OF SHIP ERECTION — WELDED TANKER

Job Sheet Series

JOB No.	TITLE
1.	Erection of Vertical and Flat Keel Assembly
2.	Erection of Flat Keel Plates Forward and Aft
3.	Erection of Shell Bottom Section Assembly
4.	Erecting Deep Tank Transverse Bulkheads
5.	Erecting Center Line Upper Deck Girder Assembly
6.	Erecting Loose Brackets in the Tanks
7.	Erecting a Longitudinal Bulkhead
8.	Erecting Bilge Section Assembly
9.	Erecting Wing Tank Transverse Bulkhead
10.	Erecting Side Shell Assembly Section
11.	Erecting Wing Tank Tie Beams
12.	Erecting Upper Deck Section
13.	Erecting After End Bottom Shell Plating
14.	Erecting a Double Bottom
15.	Erecting Stern Frame (or Stern Post) Assembly
16.	Erecting Engine Room Stanchion
17.	Erecting Web Frame with Shell Longitudinal Assembly
18.	Erecting Steering Gear Flat Assembly
19.	Erecting Generator Flat
20.	Erecting Engine Room Casing Bulkhead
21.	Erecting Side Shell Plate — Welded Plate Methods
22.	Erecting Poop and other House Bulkheads
23.	Erecting Poop Deck Sections
24.	Erecting Transverse Bulkhead 72 and 73
25.	Erecting Pump Room Bottom
26.	Erecting Forward Floors 78 to 89
27.	Erecting Ammunition Chambers
28.	Erecting Chain Lockers
29.	Erecting Bow Assembly
30.	Erecting Hawse Pipe (Tanker or Cargo)

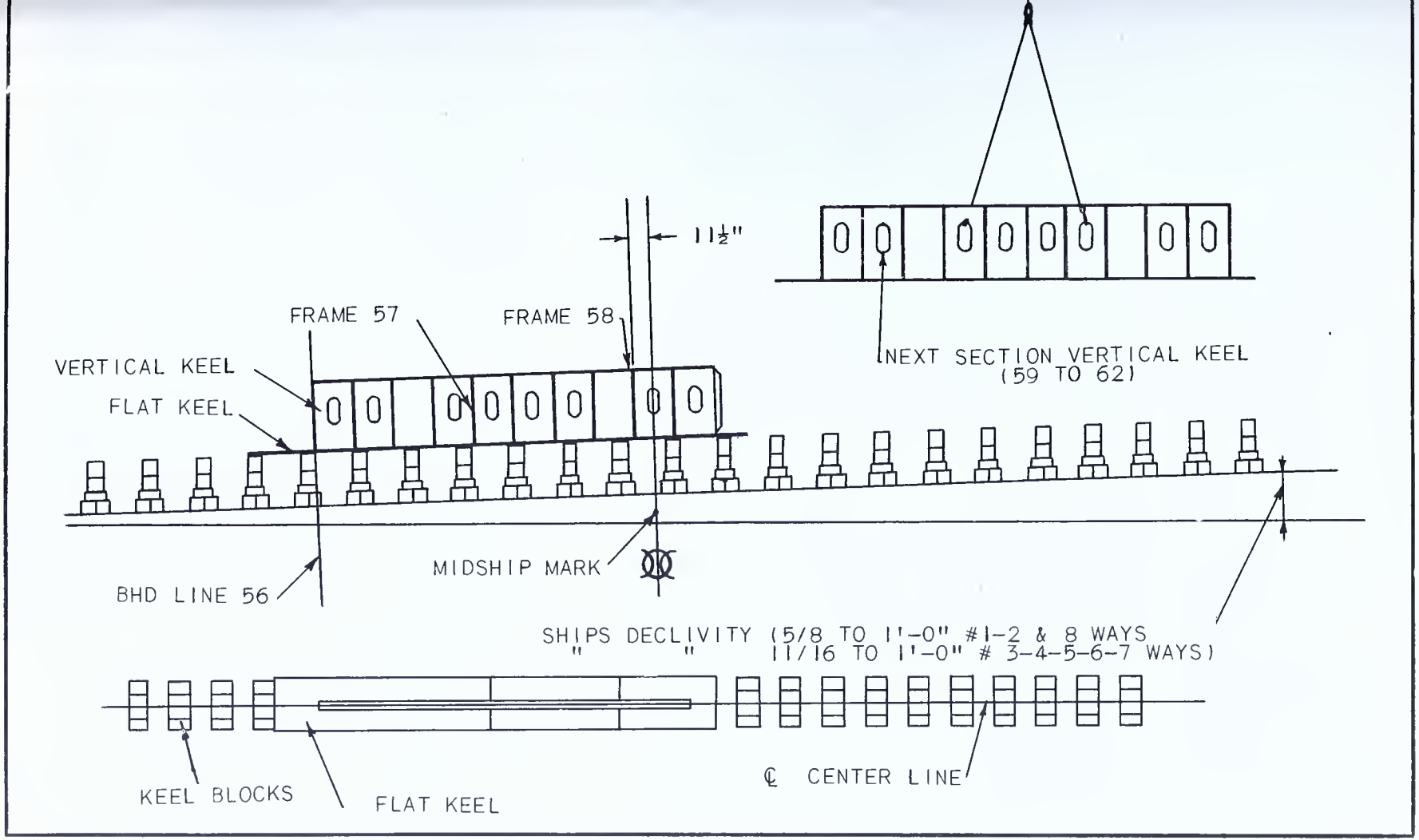


FIG. 69 — *Method of Laying and Aligning Keel*

JOB SHEET NO. 1
SEQUENCE OF SHIP ERECTION
ERECTION OF VERTICAL AND FLAT KEEL ASSEMBLY

General Information

The vertical and flat keel assembly, when brought from the fabrication shop, includes the flat keel plate, center line vertical keel, flat plate on top of vertical keel, frame brackets port and starboard, shell longitudinals on port and starboard side, and miscellaneous brackets and flat bar that belong with this section. Before the actual erection of this piece takes place, the surveyor, working with the stage builders, must align the keel blocks to conform to the declivity of the shipway and run the center and midship line with surveyors' instruments. See Fig. 69. The first piece of keel to be laid is the midship section, the location of which is determined by the two center lines the surveyor has placed on the keel blocks.

Tools used in erecting various sections of a ship may be considered standard for ship erection. Few special tools are required. (See Tools and Their Uses.)

Tools and Materials

1. Bars
2. Mauls
3. Wrenches

Equipment

Two hook pennants 7/8" in diameter or larger
Crane of 10 tons minimum capacity.

Other Mechanics Needed

A shipwright or stage builder should be on hand to line the keel sections to the center line previously prepared on the keel blocks.

Procedure

1. Determine the piece to be erected.

   The foreman of the ship erectors assigns a "gang" (leader and four men) to a job. The leader obtains the shell expansion blueprint and an erection procedure list to determine which piece of keel should be placed on the center line or at the midship point. The information necessary to recognize the plate is given in Part V, "Handling Materials."

2. Estimate weight of piece to be handled. See Table IV.
3. Obtain necessary tackle.

   The tackle necessary for this job consists of two 18′ 1¼" hook pennants which are usually hanging on the crane hook; if they are not on the hook they may be found on the ground at the front of the shipway.

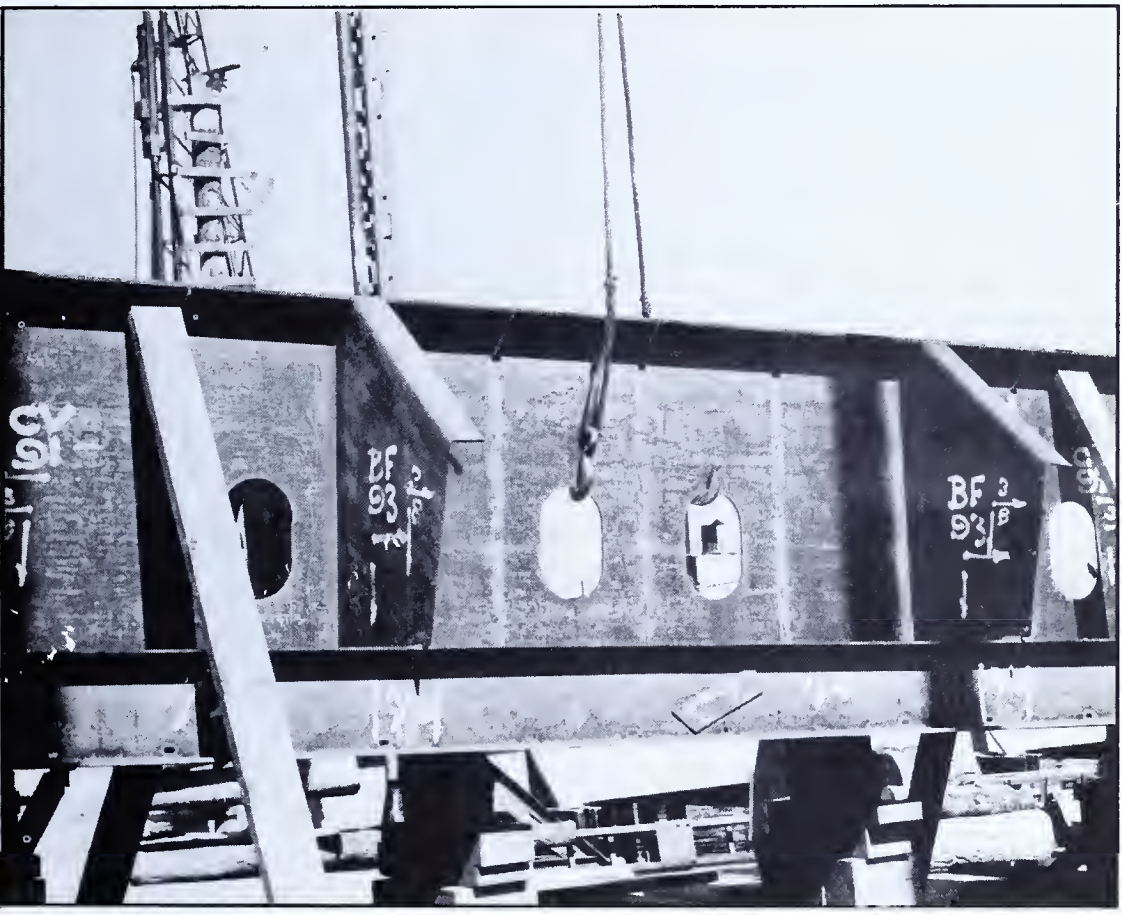


FIG. 70 — *Hook-up of Flat and Vertical Keel*

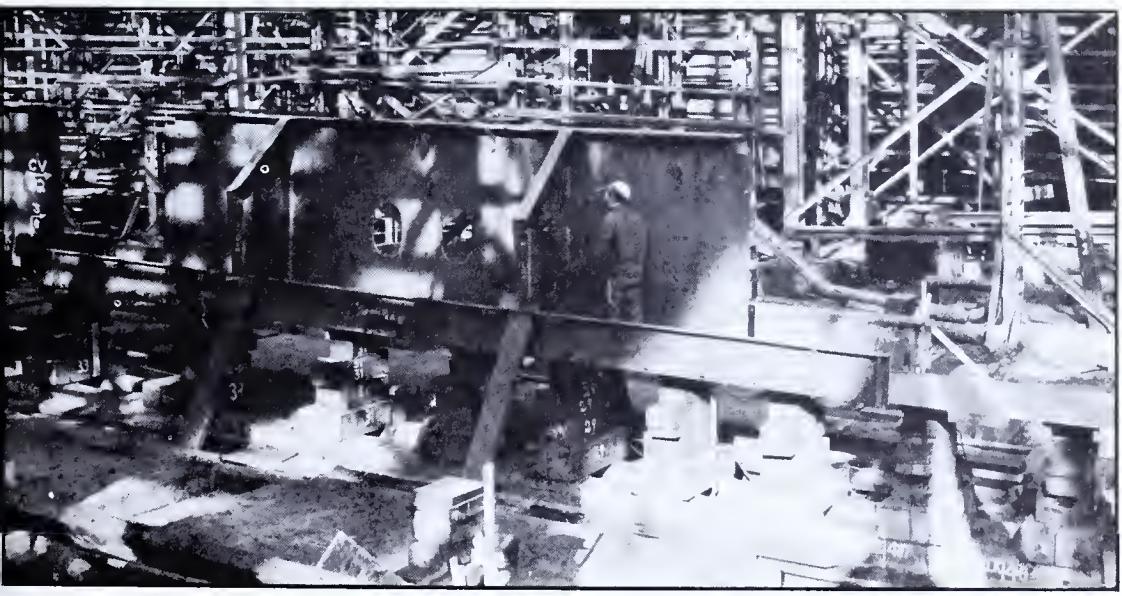


FIG. 71 — *Erected Flat and Vertical Keel Section*

4. Determine the best hook-up for the job and attach pennants.

The Hook-up as shown in Fig. 70, is made by placing the hooks of the pennants in the lightening holes from opposite sides. The hooks are moved from place to place in the lightening holes until the keel is made to conform to the declivity of the ship; the aft end of the piece should be lower than the forward end. In case there are no lightening holes in the keel, lifting pads should be welded to the flat plate on the top of the vertical keel and the hooks from the pennants fastened in these pads.

FIG. 72 — *Erected Keel, Frame 47 to 71*

5. Signal crane to take piece to location on ship.

The whistle should be blown to attract the crane operator's attention. The "raise" signal is given. As the hook is raised each of the pennants should be steadied until all the slack is taken up in the pennants; otherwise the hooks might become disengaged. Members of the gang should stand by to see that the piece being raised does not strike other objects. Workers should keep from getting under the load at any time while it is being lifted, moved or lowered.

6. Swing the piece into proper position.

Have the men steady the keel assembly until it comes to rest on the keel blocks, being careful that all set marks match when it is finally landed. When lowering the piece be very careful that no part of the staging or ship is struck by the keel.

7. Bar or otherwise move piece to correct location.

Do not use a bar to pry between the keel and blocks; this may move the block, with the surveyor's alignment marks, out of line.

If the keel is not lined up correctly, take up the weight of the keel with the crane; then have the men push the keel to the correct alignment.

8. Make temporary fastening to hold piece in position.

The shipwright will now install temporary shores at the sides of the section to prevent it from tipping or falling sideways off the keel blocks. See Fig. 72. The section is now completed and can be unhooked from the crane.

This operation is repeated for each successive keel section until all have been erected.

QUESTIONS

1. **What workmen are responsible for aligning keel blocks?**
2. **Which piece of keel is first laid?**
3. **What are the duties of a shipwright?**
4. **What are the responsibilities of a stage builder?**
5. **What information is contained in the shell expansion blue print?**
6. **In what way does an erector use an erection procedure list?**
7. **What is a pennant?**
8. **How does the erector provide for declivity in handling keel plates?**
9. **Who is permitted to signal a crane operator?**
10. **Why should workers avoid being under a load while it is being lifted or moved?**
11. **What indicates the exact location of the keel assemblies in reference to the keel blocks?**
12. **Why should one avoid using a pry between keel plates and keel blocks?**
13. **What supports the keel assembly when the crane is unhooked?**

JOB SHEET NO. 2
ERECTION OF FLAT KEEL PLATES FORWARD AND AFT

General Information

At the forward and after ends of the ship (meaning forward and aft of the cargo carrying tanks) the keel plates are separate, (not built-up sections). These flat keel plates are laid in their proper numerical order adjoining the vertical and flat keel section. They must be set with the butt end adjoining the previous plate, being kept on the center line by the erectors and shipwrights.

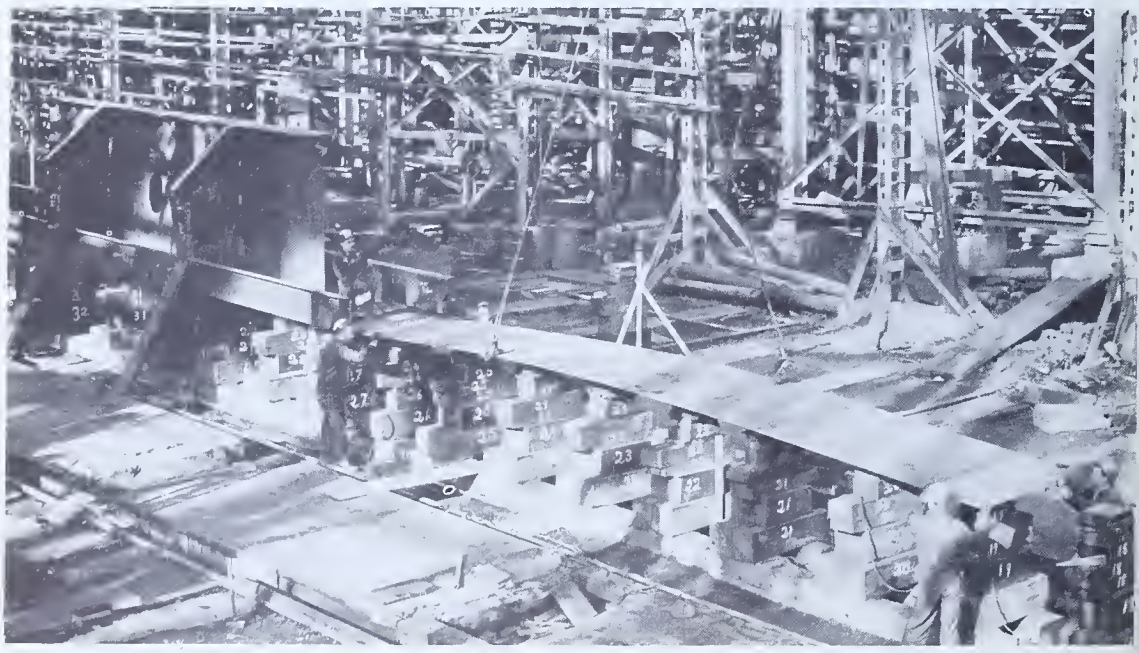


Fig. 73 — *Erecting Flat Keel Plates*

Tools and Materials

1. Bars
2. Mauls
3. Erector's wrenches

Equipment

For plates under 24 feet in length use:
- 2 — ¾" wire pennants
- 2 — ¾" shackles and bolts
- 2 — screw dogs

For plates over 24 feet in length use:
- 4 — ¾" wire pennants
- 4 — ¾" shackles and bolts
- 4 — screw dogs.

Procedure

(In that the procedure of erection as outlined in Job Sheet No. 1 pertains to most erecting jobs, with minor variations, it will be assumed that the

trainee has familiarized himself with these general erection steps. Each job instruction sheet will present the information, and variations from standard procedure, which may be necessary to correctly and safely erect the structure designated in the job description.)

1. Determine the piece to be erected.
2. Fasten two screw clamps to edge of plate.

   Two screw clamps, see Fig. 23-B, are made fast to one edge of the plate at the rack by prying the plates apart with a bar until it is possible to fasten the dogs. See. Fig. 43.
3. Fasten shackles to ring on clamp.

   The shackles are fastened to the ring on the clamp and the crane operator is signaled to hoist the load.
4. Have plate taken to place of erection.
5. Have plate laid upside-down.

   The plate is laid in an upside-down position, so that the shipwrights can strike the center line on the under side of plate.
6. Have shipwrights strike center line on under side of plate.
7. Turn plate right side up.
8. Position screw clamps to raise plate.

   If the plate is not over 24 feet long, the two screw clamps can now be moved to the exact middle of the plate, placing one clamp on each side, so that when the plate is raised it will balance, or nearly balance, on the clamps. See Fig. 73.
9. Hoist plate to slightly clear keel blocks.
10. Lower plate into place.

    As the erectors steady the plate it can be moved over the blocks and lowered into place. When lowering the plate, it is necessary that the ship erectors determine the exact position of the plate by referring to plate markings. It is also necessary that the center line of the plate match the center lines on the blocks, keeping the end of the plate butted to the previously-laid plate. See Fig. 73.
11. Have shipwright shore plate.

Erection of Remaining Keel Plates

Each flat keel plate may be erected by following the previously-described procedure, with the exception of the longer plates, where four screw clamps must be used to keep them from bending in the middle. When using four clamps, two are placed about ten feet from the forward end of the plate

directly across from each other; the other two are placed about twelve feet from the after end, directly across from each other.

After coupling the pennants and shackles to the rings of the clamps, the load should hang in a good position with the after end somewhat lower than the forward end, so that laying may be accomplished more easily. See Fig. 73.

QUESTIONS

1. **In what order are flat keel plates laid at the forward and after ends of the ship?**
2. **When are screw dogs used?**
3. **Why must a center line be established on the under side of the plate?**
4. **What procedures in Job Sheet No. 1 are similar to those required in Job Sheet No. 2?**
5. **How would you place the screw dogs on the plate according to the length of the plate?**
6. **When must four screw dogs or screw clamps be used?**
7. **Why must a keel plate be properly aligned on its center line with its keel blocks?**

JOB SHEET NO. 3
ERECTION OF SHELL BOTTOM SECTION ASSEMBLY

General Information

Shell bottom sections are assembled in the fabrication shops to include the shell plates A, B and C. See Fig. 74. These plates are welded edge to

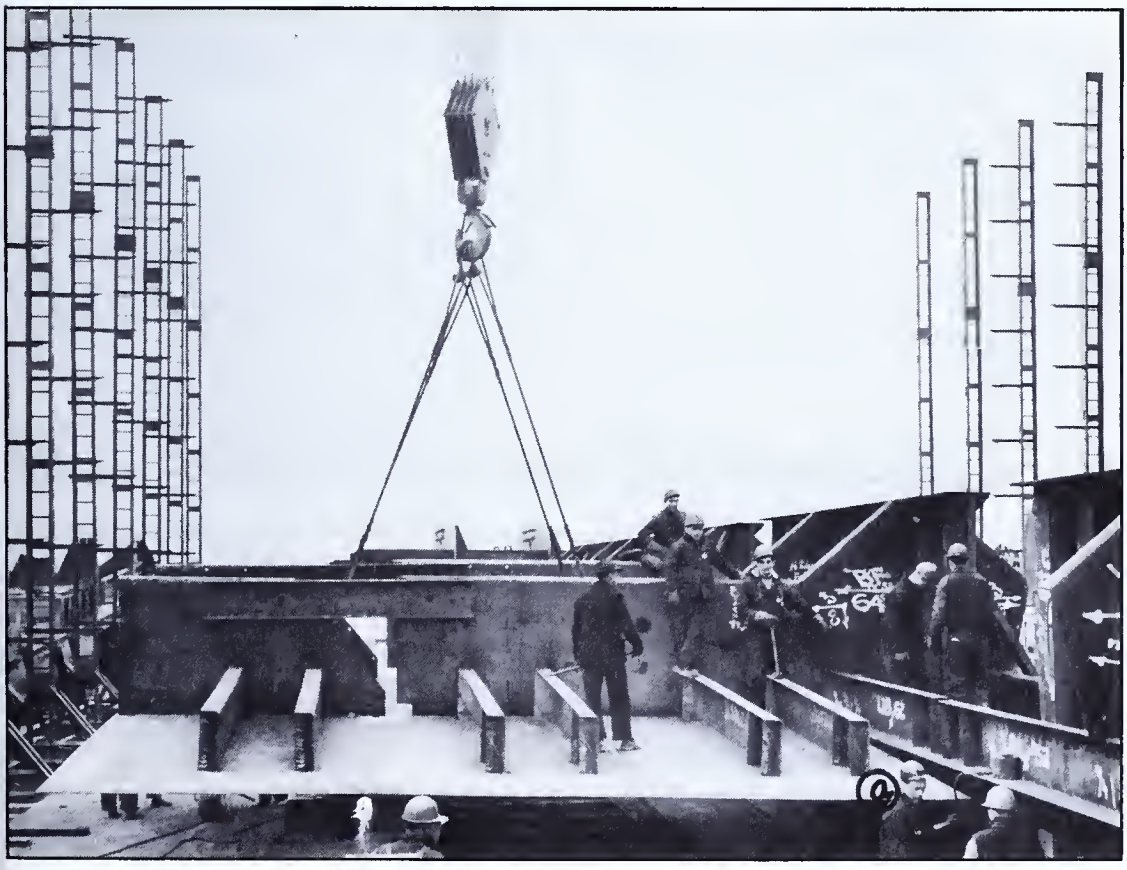


Fig. 74 — *Shell Bottom Section Assembly*

edge so that they become one large plate. Frame members from the vertical keel outboard to the bilge section and the shell longitudinals are welded to these plates. See Fig. 74. These bottom sections, when erected, form the bottom of the ship.

Tools and Materials

1. Bars
2. Mauls
3. Wrenches
4. Bolts, nuts and washers ¾″ and ⅞″ size
5. Pneumatic wrench
6. Chucks and Sockets for ¾″ and ⅞″ nuts
7. Four or five drift pins
8. Steamboat ratchet
9. Two pieces of angle iron 8″ long with holes in both toes. See Fig. 75

OTHER MECHANICS NEEDED: Shipwrights, carpenters, or stage builders.

PROCEDURE

1. Determine the piece to be erected.
2. Insert hooks into the lifting pads as shown in Fig. 76. The plate will hang level when hooked up in this manner.
3. Signal crane operator to take up slack in pennants.

   Stand by to see that all hooks pull up properly, and do not become detached. Also, see that the wire rope does not become twisted.
4. Hoist section clear of ground.
5. Signal crane operator to take section to part of ship where it is to be erected.
6. Determine exact location of section assembly.

Equipment

1. Four hook pennants of one inch wire rope, if load is eighteen to twenty tons.
2. Crane — minimum capacity 20 tons.
3. If the crane has two hoists, have available two ¾″ wire rope pennants and shackles for the other hoist.

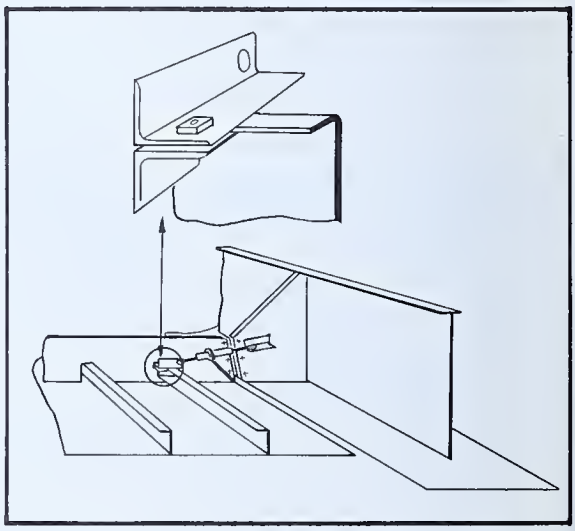


FIG. 75 — *Use of Angle Iron to Hook up Ratchet*

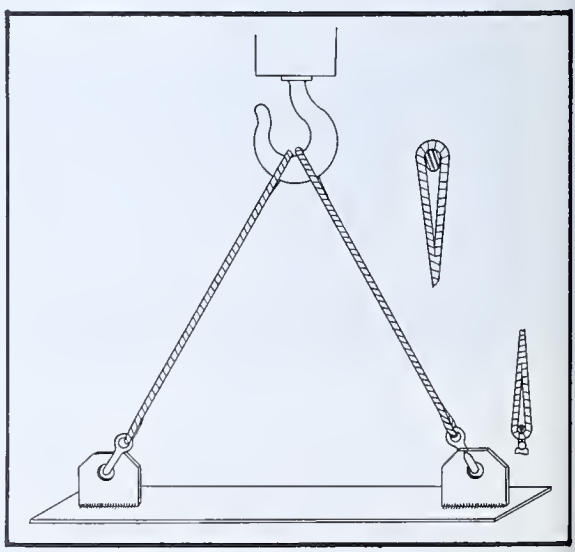


FIG. 76 — *Correct Method of Placing Hook in Pads*

The exact location will be determined by the frame numbers on the section and the port or starboard markings. Inboard (I. B.) and outboard (O. B.) markings can be checked to see that the piece has not been mismarked, also the forward end (F. E.) and the after end (A. E.).

7. Lower section into place.

The inboard edge of the "a" plate butts against the outboard edge of the keel plate; the frames are made to lap on the correct side of the frame bracket on the keel section. See Fig. 74.

8. Spud connection holes in either end of assembly.

9. Align remaining holes, insert bolts and tighten.

The remaining holes can now be lined and full size bolts inserted (usually 7/8") either with the spud wrench or the pneumatic wrench. Pull the bolts tight. See Fig. 77.

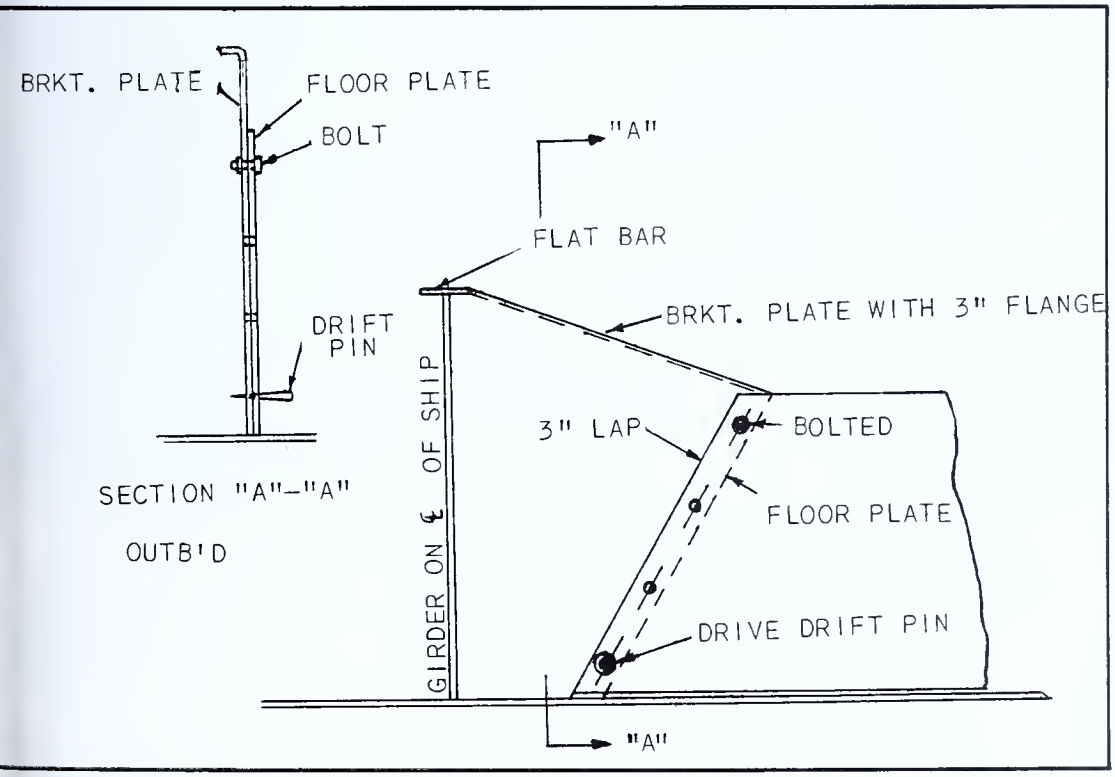


FIG. 77 — *Aligning Holes with Drift Pins*

10. Have shipwrights shore up section before releasing crane.

11. Signal crane to slacken off.

12. Stand by to see that hooks do not catch on any obstruction while the operator takes the crane away.

Setting Shell Section into Place

If the shell section does not hang properly because the lifting pads are not properly located, lower the auxiliary hoist and hook on to the low corner or side with $\frac{3}{4}$" wire pennants. The section can now be tilted to a position which may greatly help with the erection and shorten the time it would otherwise take to do the job. See Fig. 78. In the event that the section does not swing easily into place, one end of the ratchet is connected to the keel section, and the other end to the shell section. By working the ratchet the section can be forced into place.

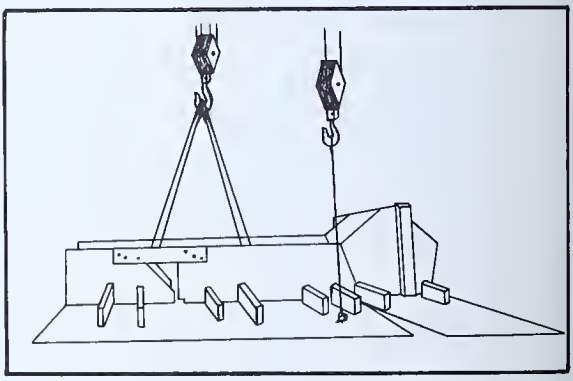


Fig. 78 — *Use of Auxiliary Hoist*

If the connecting holes do not line up correctly, insert a drift pin and maul it in. See Fig. 77. As the section is drawn into place, insert the bolts in the connections and tighten.

A full size bolt should be used in all connecting holes where possible; however, sometimes it will not be possible to insert the full size bolt, and one of a smaller size must be used.

QUESTIONS

1. **What shell plates are included in a shell bottom section?**
2. **What other members are included with the shell bottom sections?**
3. **What point of advantage may be gained by using a pneumatic wrench?**
4. **How may ratchets be attached at lightening holes without welding?**
5. **Why are hooks inserted with the open part of the hooks facing outward?**
6. **Why is it necessary to closely observe the hooks as the slack is being taken up?**
7. **What markings indicate the locations of this assembly?**
8. **How may the auxiliary hoist be used in placing a shell section?**
9. **What are the general procedures as outlined in Job Sheet No. 1?**

JOB SHEET NO. 4
ERECTING DEEP TANK TRANSVERSE BULKHEADS

General Information

The deep tank transverse bulkheads (Fig. 79) are assembled in the fabrication shops to include the bulkhead plating, vertical web stiffeners, face

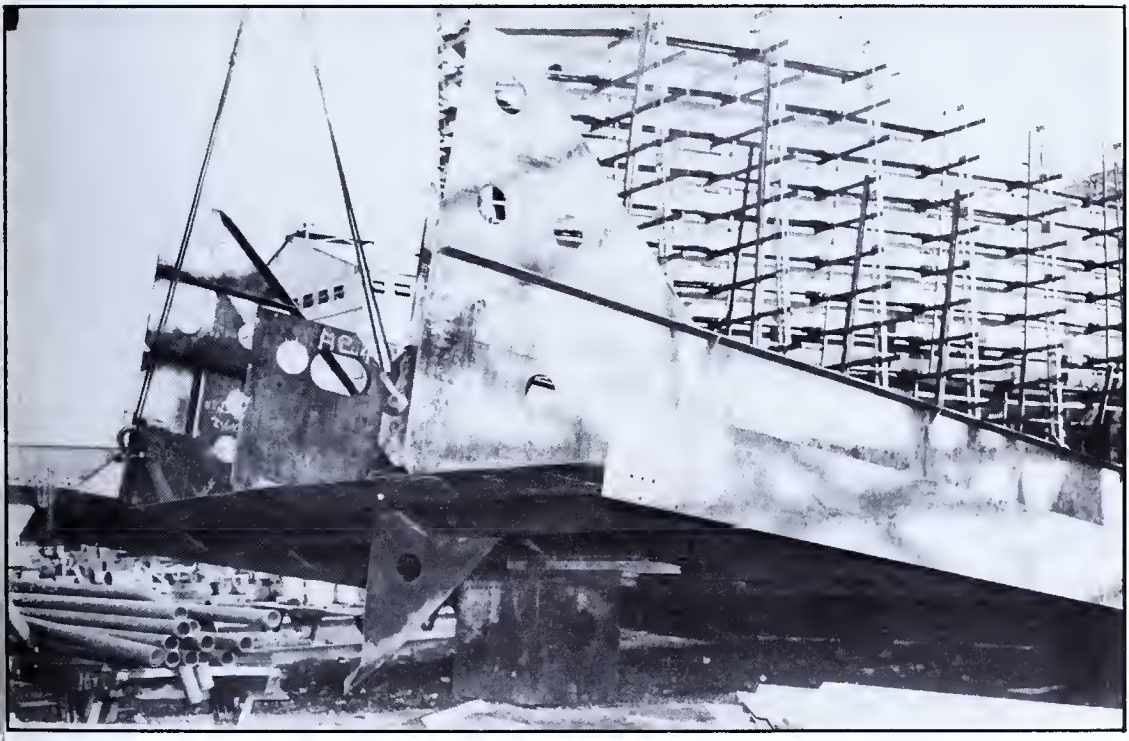


Fig. 79 — *Transverse Bulkhead and Hook-up With Proper Method of Support at Bracket*

plates, and all brackets and stiffeners which can be attached to it without detracting from easy handling and erecting.

The erector's job is to erect the bulkheads on the ship in their proper places as designated by bulkhead numbers.

Tools and Materials

1. Bars
2. Mauls
3. Spud wrenches
4. Wooden wedges
5. Bucket of ¾" and ⅞" bolts, nuts, washers

Equipment

Set of four hook pennants (1¼") for handling.

Set of heavy erection pennants of a capacity to handle a load of 20 to 25 tons safely.

Two large shackles with sufficient safe lifting capacity to handle a load up to 20-25 tons.

Crane with a 20 to 25 ton safe capacity.

Note: All equipment must be of sufficient capacity to provide required safety factors.

PROCEDURE

(General procedures described in Job Sheet No. 1 are not reprinted in this job sheet. It is assumed that the trainee understands, and has memorized the general procedures of erection.)

Note: Bulkheads are handled in two ways. Procedures are listed for each method.

Method No. 1
Tipping Bulkhead into an Upright Position Directly from the Ground

1. Block bulkhead to prevent bending the bracket. See Fig. 79.
2. Couple shackles and pennants to lifting pads. See Fig. 79.

   While doing so make sure the lifting pads are in good condition.
3. See that the bottom edge of bulkhead is resting on the ground.

   To turn a bulkhead upright on the ground, the bottom edge of the bulkhead must be resting on the ground itself, on an even surface, so the plating will not be bent as the bulkhead is swung upward while resting on its bottom edge.

   CAUTION: The crane must be moved at all times to keep the crane block centered over the load so that, as it is raised clear of the ground, it will not swing sideways and perhaps cause damage or injure workmen.
4. Signal crane to carry bulkhead to proper location for erecting.

   While moving bulkhead to its position, keep it clear of staging, since the weight, if allowed to swing against the staging, will break down spawls or planks. Watch for proper clearance; if it is necessary to go over the top of the ship or staging, do so only while watching the clearance, directing the crane operator accordingly. On windy days it will be necessary to fasten a tag line (¾″ or 1″ manila rope about 150′ long) to one edge of the bulkhead to prevent it from swinging around, thus eliminating damaging staging, or denting or bending the edges or brackets of the bulkhead.
5. Lower bulkhead into opening between the two vertical keel sections where it is to be erected.

   Swing the bulkhead to port or starboard to match the center line of the bulkhead as nearly to the center line on the keel plate as possible.

   As the bulkhead is being lowered, watch that all is clear. Have bars at hand, using them to guide the edge down between the shell longitudinals in each tank.
6. Insert doubled wooden wedges at lower corners of after side of bulkhead. See Fig. 80.

   When the lower edge of the bulkhead is about four inches above the bottom shell it will be necessary at two points (one on each side of ship, to port and to starboard of the center line) to insert two wooden wedges (one on top of the other, or doubled) at the end of a shell longitudinal on the after side of the bulkhead. The weight of the bulkhead now rests against the wedges, with sufficient tension on the pennants to keep the bulkhead in an upright position.

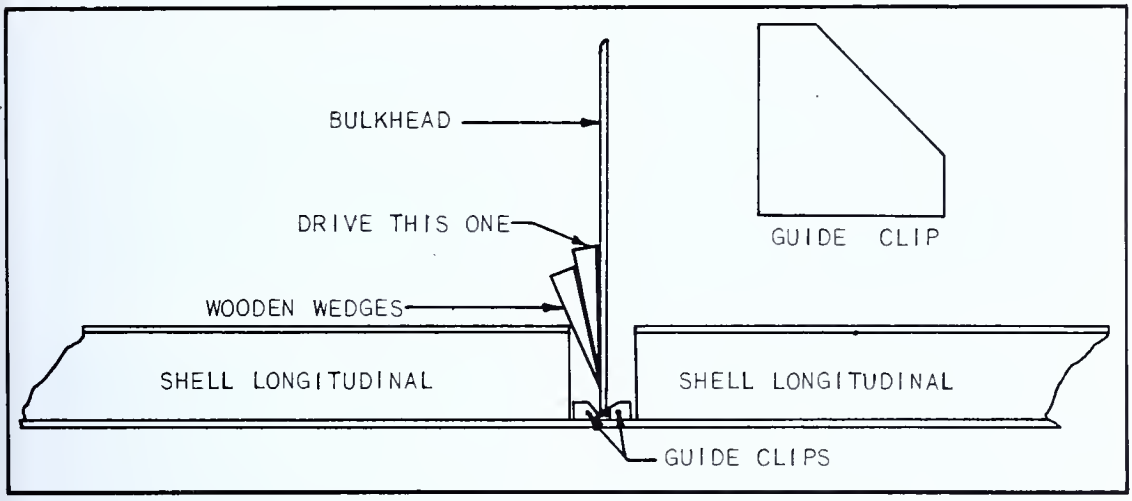


FIG. 80 — *Wedges Inserted at Lower Corner of Bulkhead*

7. Tilt bulkhead to conform with declivity of shipway.

   Travel the crane aft so the top of the bulkhead will lean aft, mak- the bulkhead at a right angle with the bottom of the ship.

8. Drive wooden wedge (Fig. 80) next to the smooth plate with a maul, until the edge of the plate is about centered, or half way between the ends of the longitudinals.

9. When both sides are even, slack the crane down easily until the bulkhead rests firmly on the shell plating.

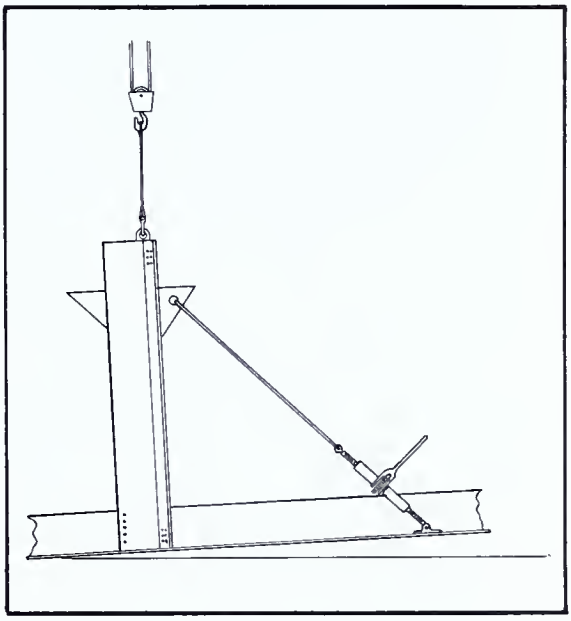


FIG. 81 — *Bulkhead Leans at Top to Declivity of Shipway*

10. Bolt up the vertical web connection to the center line vertical keel with full-sized bolts in all holes.

11. Have shipwrights attach a cable (wire rope) to the forward side of the bulkhead, with a ratchet at the lower end. (See Fig. 81)

12. When the cable is tightened the bulkhead may be unhooked from the crane.

    While removing the large shackles at the top of the bulkhead, do not allow any workmen to remain below. A nut or bolt dropped from one of the large shackles striking a workman would cause a serious accident.

Method No. 2

Turning Bulkhead Upright Where There is Not Space to Lay It on Ground Before Raising

1. Raise bulkhead in flat position, on one crane. (See Fig. 91).
2. Swing bulkhead to a position where the second crane can be coupled to the top lifting pads. (See Fig. 79).
3. Hoist top of bulkhead sufficiently high to prevent bending the bracket as the other crane lowers the bottom of the bulkhead to the ground (temporarily).
4. Single out the four hook pennants.

   "Singling out" is doubling the length of pennants by fastening the hook of one pennant to the eye of a second pennant. In place of the four short pennants we now have two long pennants.
5. Hook singled-out pennants into either the lowest lifting pads or in two of the lowest lightening holes.
6. Raise bottom edge of bulkhead to about six feet above ground, and hold this position. (See Fig. 92).
7. Signal top crane to lift bulkhead until all of the weight is carried by the top crane.

   As the load goes up, keep the load centralized to prevent undue swinging.
8. Unshackle lower crane pennants, removing hooks from bulkhead.

   When the top crane has raised the load high enough to take all the load off the crane which is hooked to the bottom, the bottom crane is unshackled and the hooks removed from the bulkhead.
9. Signal crane (only one crane is now attached) to carry bulkhead to proper location for erecting.

   While moving the bulkhead to its position, keep it clear of staging, since the weight, if allowed to swing against the staging, will break down spawls or planks. Watch for proper clearance; if it is necessary to go over the top of the ship or staging, do so only while watching the clearance, directing the crane operator accordingly. On windy days it will be necessary to fasten a tag line (¾″ or 1″ manila rope about 150′ long) to one edge of the bulkhead to prevent it from swinging around, thus eliminating damaging staging, or denting or bending the edges or brackets of the bulkhead.

10-17. Follow procedures indicated in steps 5 to 12 given for Method No. 1.

NOTE: Each of these bulkheads requires about the same erection procedure.

If you are to erect another bulkhead move your tools and equipment to the location. Do not leave equipment and then when it is needed, have to search for it.

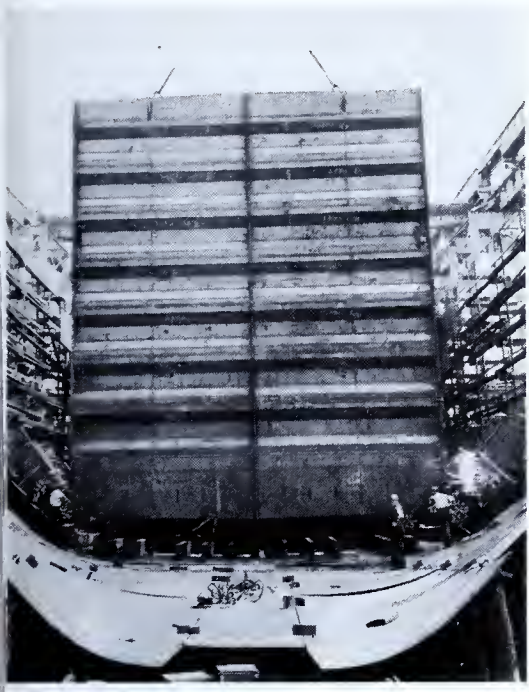


FIG. 82 — *Center Section of Corrugated Transverse Bulkhead Being Erected*

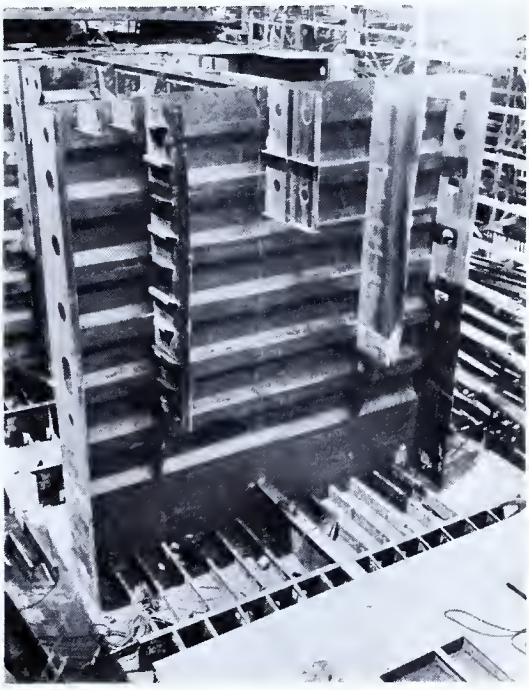


FIG. 83 — *Center Section of Transverse Bulkhead In Place*

QUESTIONS

1. **What parts are assembled to the deep tank transverse bulkhead?**
2. **To what extent do the procedures in Job Sheet No. 1 apply to this job (No. 4)?**
3. **What two methods of handling bulkheads are used?**
4. **Why is it necessary that the crane be moved while lifting the bulkhead assembly to an upright position?**
5. **What precaution must be observed in handling the bulkhead from one position to another?**
6. **How is a tag line used?**
7. **What bulkhead markings must be matched with the center line on the keel plate?**
8. **Describe the use of wooden wedges to facilitate the erecting of the bulkhead.**
9. **How is the bulkhead tilted to conform to the declivity of the shipway?**
10. **Why should full size bolts be used in all connections?**
11. **How is the bulkhead guided?**
12. **How is the bulkhead handled when there is not enough space to lay it on the ground?**

JOB SHEET NO. 5
ERECTING CENTER LINE UPPER DECK GIRDER ASSEMBLY

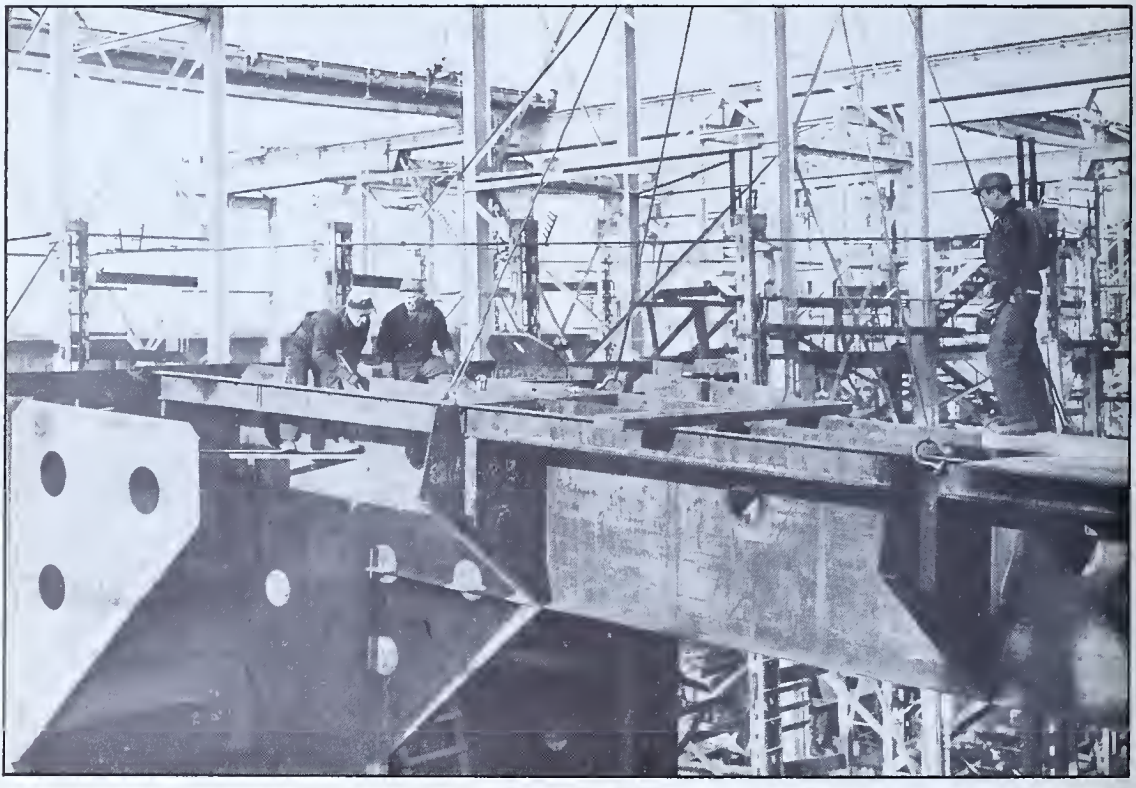


FIG. 34 — *Center Line Upper Deck Girder*

GENERAL INFORMATION

The center line upper deck girder assembly, as constructed in the fabrication shop will include the upper deck "A" plate (known as the "rider" plate), the center line vertical girder, the frame brackets for two frames on each side of the center line, and the port and starboard No. 1 upper deck longitudinals.

This section is similar to the center line keel assembly, but it is located at the top of the ship. The

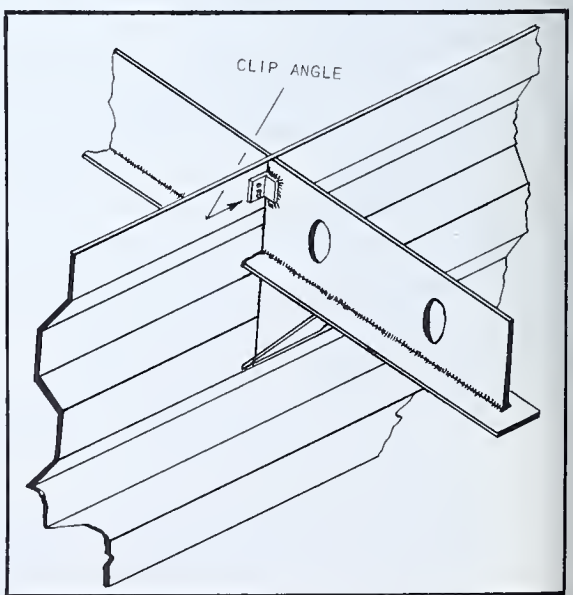


FIG. 85 — *Longitudinal Girder Connection to Smooth Side of Bulkhead*

girder extending from one transverse bulkhead to the next, is one tank in length, and bolts to the center line vertical web on one bulkhead, and to the smooth side plating on the other, by means of a three-hole clip angle which is welded to the end of the center line vertical girder.

Tools and Materials

1. Bars
2. Maul
3. Wrenches
4. Bolts, nuts and washers, ¾″ and ⅞″ size.

Equipment

Two hook pennants of ¾″ or larger wire rope
Crane

PROCEDURE

1. Determine the piece to be erected.

   The foreman of the ship erectors assigns a "gang" (a leader and four men) to a job. The leader obtains the proper blueprints and an erection procedure list to determine which piece of girder should be placed at the midship section of the ship.

2. Inspect lifting pads.

3. Hook the load to be erected.

   When hooked for erecting, the after end should be slightly lower to correspond to the declivity of the shipways. If it is not, remove from the crane the eye of the hook pennant that is on the after end lifting pad, and extend its length by placing a shackle on the crane hook and connecting this shackle to the eye of the hook pennant. This will give the desired hook-up with the after end lower.

4. Signal crane operator to take girder to required location.

5. Lower deck girder into place.

   When lowering the deck girder into place, difficulty may be encountered if one of the bulkheads is not plumb. If the space for erecting is too short, one of the bulkheads must be moved or plumbed by the shipwrights. See Fig. 86.

6. Bolt girder into place. See Fig 84.

   The end of the girder that does not have the overhanging deck plate will have to be bolted into position. However, on the end where the plate extends over the bulkhead it will be difficult to reach the connecting holes unless special staging has been built before erecting the girder.

   The forward end connection of the girder to the center line web of the bulkhead should be bolted first.

   If the bulkheads are spread too far apart, they may be brought into position by inserting long bolts in the erection clips and tightening. See Fig. 107.

7. Slacken off and unhook crane.

8. Remove tools and equipment to location of next erection job.

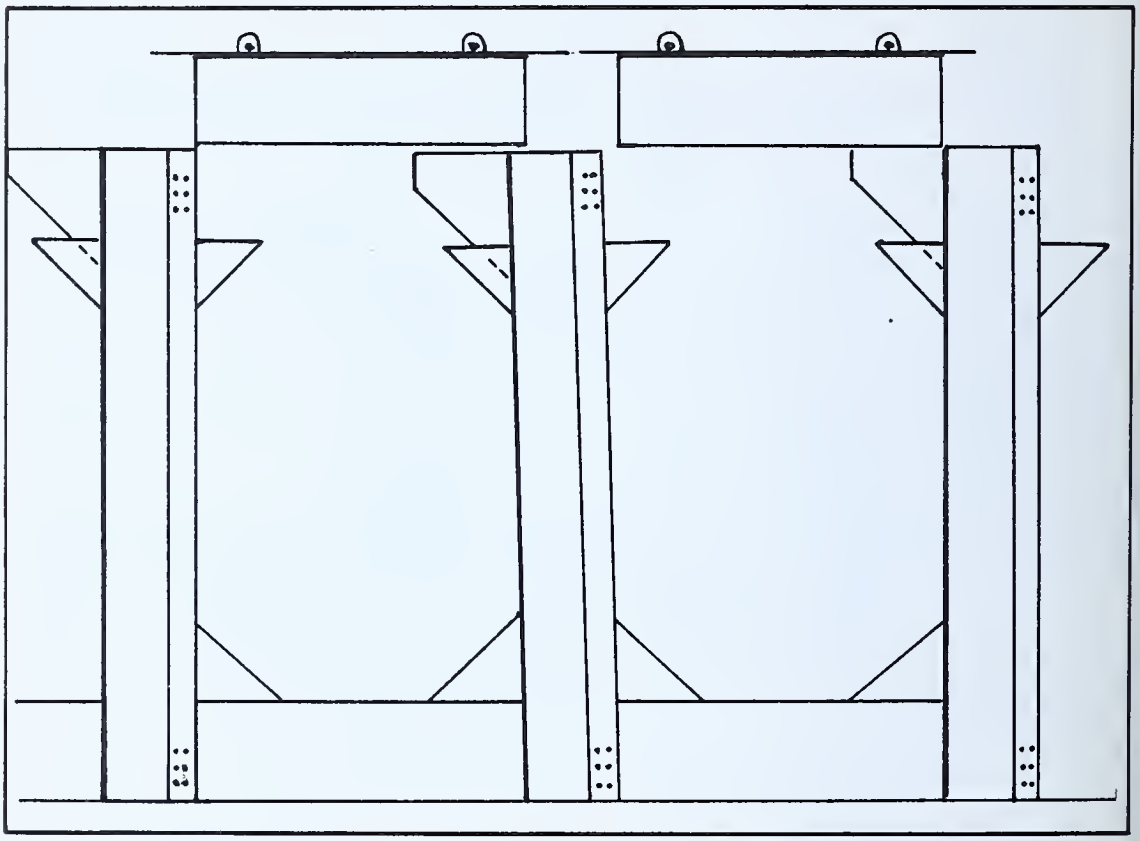


FIG. 86 — *Bulkhead Out of Plumb*

QUESTIONS

1. **What members are included in the center line upper deck girder assembly?**
2. **What other assembly is similar to the center line upper deck girder assembly?**
3. **Why is the after end of the assembly handled so that it is low?**
4. **When is it necessary to move bulkheads when erecting this assembly?**

JOB SHEET NO. 6
ERECTING LOOSE BRACKETS IN THE TANKS

General Information

Sort small loose brackets and place in proper tanks when bulkhead erection is complete. These brackets are located as shown in Fig. 87.

Large brackets at the center line web and at the ten-foot off-center line web are erected as they are placed in the tanks.

Erecting Large Brackets

Tools and Materials

1. Maul
2. Spud Wrench
3. Bars
4. Guide dogs

Equipment

¾″ pennants and shackles
Crane

Additional Man Needed: Welder.

Procedure

1. Locate and identify brackets.
2. Shackle pennant to clip angle at the top of each large bracket.

   A screw dog may be attached if a clip has not been provided.
3. Signal crane to take bracket to point of erection.
4. Position bracket for erection.

   The brackets are numbered to correspond with bulkheads or frames to which they are to be erected. Markings include hull number, charge number, piece mark, frame number, etc.

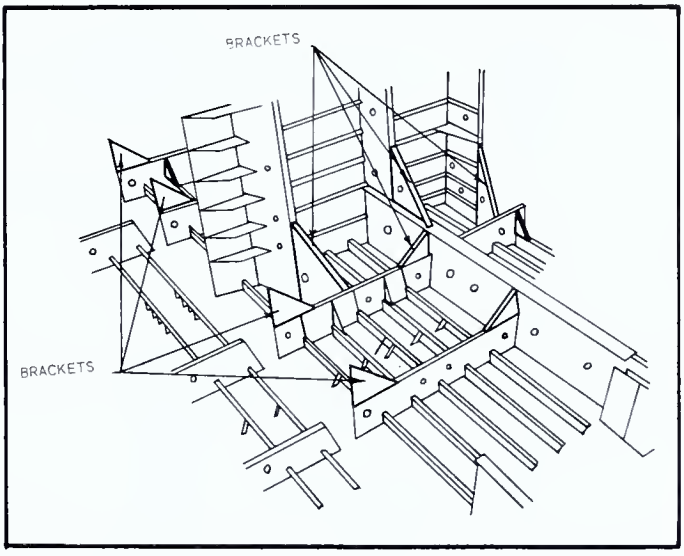


Fig. 87 — *Loose Brackets Erected on Center Line and 10′ Off Center Line*

5. Secure bracket in position.

   When the bracket has been placed in its proper position, it is held by a series of guide dogs which are welded on each side of the set lines along the top of the vertical keel and on the vertical web.
6. Unshackle pennants.

QUESTIONS

1. Indicate two ways in which the crane may be fastened to the top of the bracket.
2. How is the position of a bracket determined?
3. What holds the bracket in place after it is in position?
4. What are guide dogs?
5. What are brackets?

JOB SHEET NO. 7
ERECTING A LONGITUDINAL BULKHEAD

General Information

Longitudinal bulkheads are those which run lengthwise of the ship. Each bulkhead extends from one transverse bulkhead to the next — the length of one cargo tank. These bulkheads will be handled previous to erecting, exactly as the transverse bulkheads were handled, taking care not to bend brackets on the under side. See Fig. 79.

Tools and Materials

1. Bars
2. Maul
3. Bucket of ¾″ bolts, nuts and washers.

Equipment

Pennants of a safe working load capacity of 24 tons

Crane

On windy days a tag line should be used. A ratchet may be necessary. If so, a welder will be needed.

Procedure

1. Locate and identify assembly to be erected.

   (General procedures described in detail in Job Sheet No. 1 are not repeated here.)

2. Shackle longitudinal bulkhead to crane.

   When shackling a longitudinal bulkhead for erection, allowance must be made for the declivity of the shipway. This is done by placing an extra shackle on the pennant which is attached on the after end of the bulkhead. See Fig. 88. When raised clear of the ground by the crane, these extra shackles cause the after end to hang heavier or lower than the forward end, which makes allowance for declivity. If the proper declivity is not secured by adding one shackle, it may be necessary

FIG. 88 — *Longitudinal Bulkhead Showing Declivity Hook-up*

to use a wheel strap. If the shackle produces too much declivity, it may be necessary to use a smaller shackle.

3. Determine specific location of bulkhead.

The bulkhead location is determined by the frame numbers of its frames and its two extreme ends, and by its port and starboard marking. When the proper location is determined, see that all temporary stiffeners or other obstructions are removed from the path of the bulkhead.

4. Signal crane to take bulkhead to place of erection.

While taking the bulkhead to the proper position on the ship, care must be exercised to prevent damaging the staging. On windy days a tag line should be attached to the bulkhead.

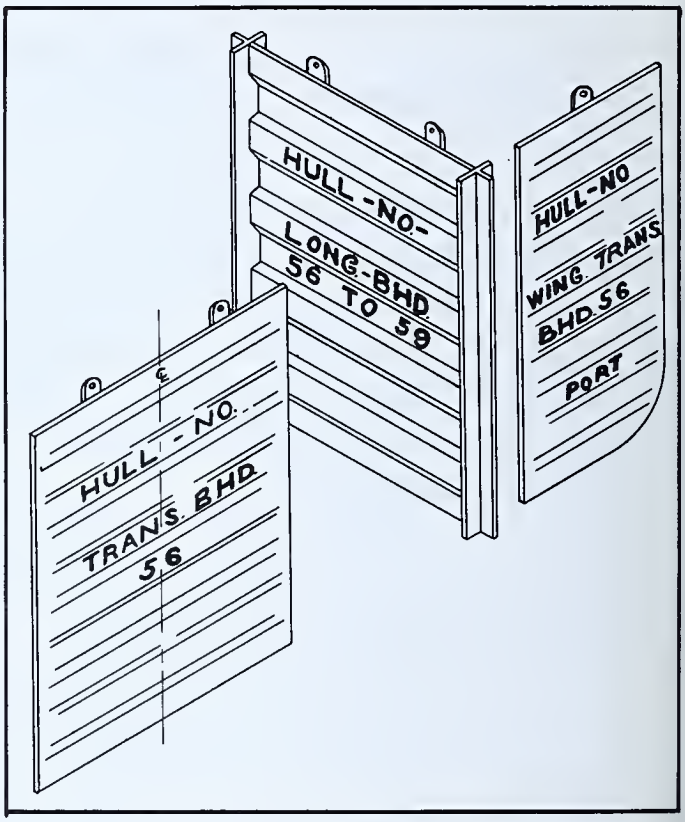


FIG. 89 — *Bulkhead Markings*

5. Lower the bulkhead into position.

The bulkhead is lowered into position so that all frame connections lap on the proper side. This may be determined by the flange on the frame. The blueprint should also be consulted.

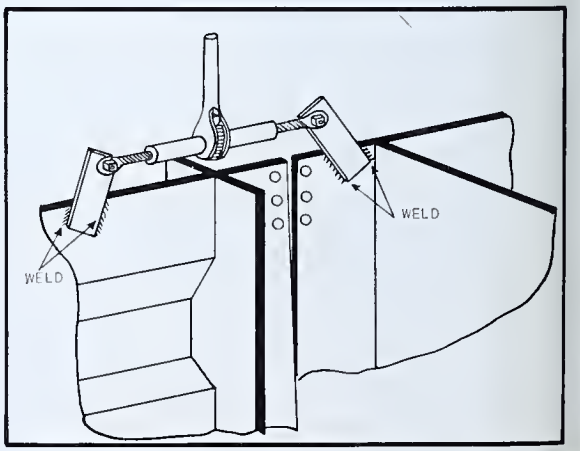


FIG. 90 — *Pulling Longitudinal Bulkhead Connections With Steamboat Ratchet*

6. Bolt longitudinal bulkhead to transverse bulkheads at either end.

The procedure used in bolting connections will vary with the individual conditions encountered. If the transverse bulkheads have a tendency to be farther apart at the top than at the bottom, one connection at the bottom may be bolted first. When this connection is bolted the crane is signaled to raise the bulkhead so that

the top connection is pulled into line with the transverse bulkhead. The top connection is bolted securely into place. When the bulkhead is lowered on the crane it will cause the transverse bulkhead just bolted to it to be pulled into position.

The connections on the remaining transverse bulkhead may be bolted at either top or bottom, whichever connection is more easily made. For the last connection it may be necessary to use a ratchet to pull the bulkheads into alignment; if so, temporary staging will be necessary and the service of a welder must be secured to weld clips for attaching the ratchet. When the bulkhead has been connected to the top connections on both ends, and at least one connection made on the bottom, the crane may be slackened off and unhooked.

All longitudinal bulkheads involve similar erection procedures, although conditions may vary on different bulkheads, in that transverse bulkheads may lean slightly forward in one job, and may lean slightly aft in another. These conditions must be overcome by using a ratchet in making up connections.

Always have tools and bolts ready for the next bulkhead.

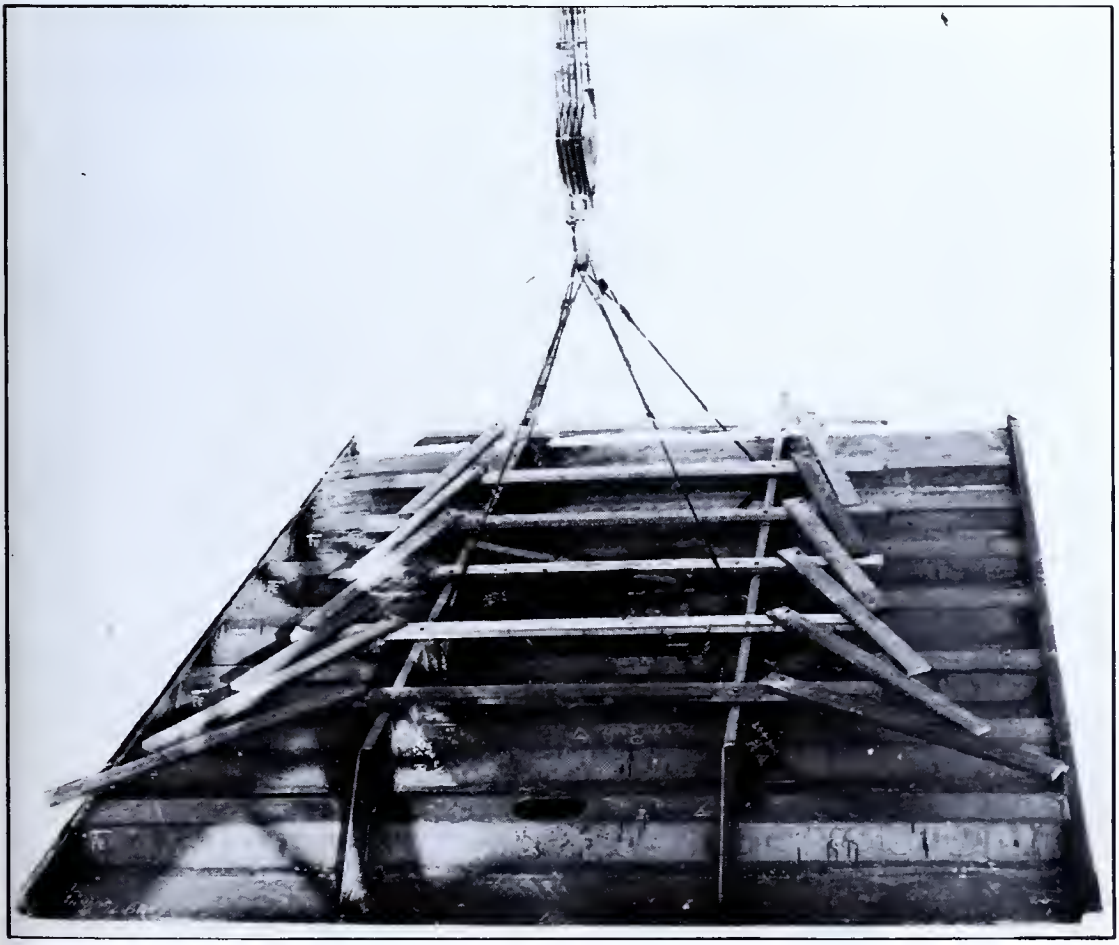


FIG. 91 — *Handling Bulkhead in a Flat Position Using Four Hook Pennants*

FIG. 92 — *Turning Bulkhead Upright Using Two Cranes*

QUESTIONS

1. **What is a longitudinal bulkhead?**
2. **How are these bulkheads handled prior to erecting?**
3. **How is the hook-up arranged to allow for declivity?**
4. **What location marks are used in erecting this bulkhead?**
5. **How is the proper frame connection lap determined?**
6. **Indicate several circumstances under which a ratchet will be used in making up connections.**

JOB SHEET NO. 8
ERECTING BILGE SECTION ASSEMBLY

General Information

The bilge section assembly is made in the fabrication shops to include the two bilge frames, the shell longitudinals, and the shell plate "E". The entire assembly will weigh approximately eight tons, if the vessel being erected is a tanker of about 18,000 dead weight tons.

There are about fourteen bilge sections to a ship, the erection of all sections after the first being repetitive.

Tools and Materials

1. Bars
2. Maul
3. Bucket of 7/8" and 3/4" bolts with washers

Equipment

Two pennants 3/4"
Two shackles
Two shackle bolts 7/8"
Safe working load of eight tons
Pneumatic wrench

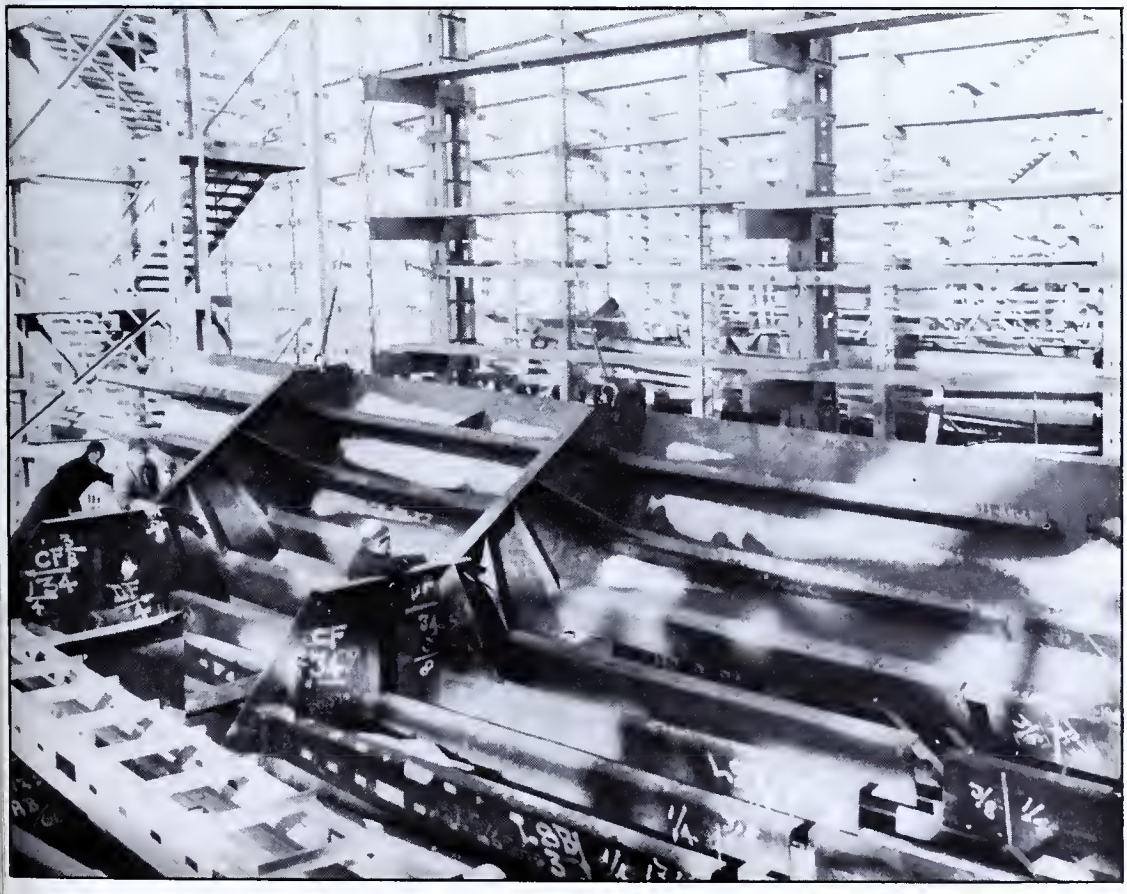


Fig. 93 — *Erecting Bilge Assembly*

PROCEDURE

1. General procedures described in detail in Job Sheet No. 1 are not repeated here.
2. Couple shackles to top of bilge frames.

   On some bilge sections where the overhang of the "E" plate is on the forward end, it will be necessary to extend the pennant which is hooked to the after end by the use of a wheel strap to secure the proper declivity for erecting.
3. Signal crane operator to take assembly to location of erection.
4. Lower bilge assembly into position of erection.

   Frames must be placed on proper sides as illustrated at "a", Fig. 94. See also, Fig. 93.

   The correct location of frames may be determined from the position of the flanges on the frames.
5. Spud (align) top hole and bolt at "b", Fig. 94.
6. Lower section until remaining holes line up.
7. Insert full size bolts, usually ⅞″ size, in all connecting holes, and pull these bolts very tight. The use of the pneumatic wrench is recommended.

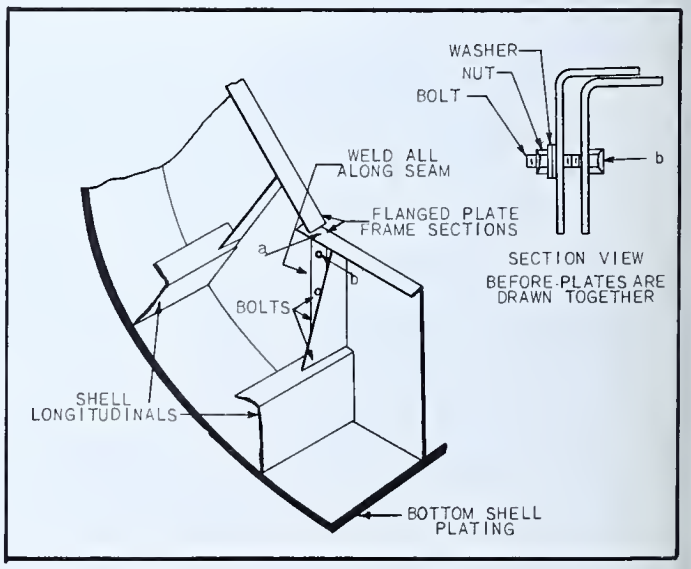


FIG. 94 — *Bilge Frame Connection*

8. Have shipwrights shore section in position while holding section with crane.
9. Unhook shackles and pennants.
10. Take tools and equipment to next working location.

QUESTIONS

1. **What members are included in the bilge section assembly?**
2. **Approximately how many bilge sections are included in a ship?**
3. **What markings are necessary so that the bilge sections may be located?**
4. **What is a wheel strap?**
5. **What determines the correct location of frames?**
6. **What trade group is responsible for shoring?**

JOB SHEET NO. 9
ERECTING WING TANK TRANSVERSE BULKHEAD

General Information

Wing tank transverse bulkheads extend from the longitudinal bulkhead outward to the shell. These bulkheads are assembled in the fabrication shops. See Fig. 95.

Each bulkhead erected is a repetition of the procedures indicated in this job sheet.

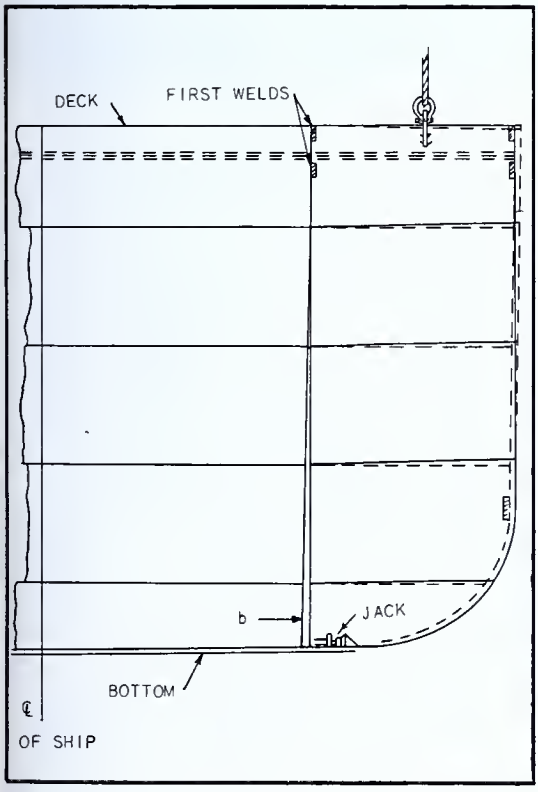


Fig. 95 — *Connecting Transverse Wing Bulkhead*

Fig. 96 — *Erecting a Wing Tank Transverse Bulkhead*

Tools and Materials

1. Bars
2. Maul
3. Twelve 7/8″ bolts, 6″ long for each bulkhead
4. Twelve 3/4″ bolts, 6″ long for each bulkhead

Equipment

One short pennant or wheel strap
One large shackle with shackle bolt, safe capacity, 15 tons
Crane
Two hook pennants of safe capacity of 15 tons

Procedure

The bulkhead should be laid out in an open spot large enough for turning upright.

1. Locate bulkhead by means of the bulkhead number and the port or starboard markings.

   Since these bulkheads will extend very close to the staging while being erected, extreme care must be exercised to see that staging planks are not dislodged from their positions. Be sure that spawls are not broken. If spawls are broken or planks dislodged see that these are made secure before leaving the job.

2. Shackle pennant to lifting pad.

   The lifting pad at the top of this bulkhead is located so that only one pad is necessary.

FIG. 97 — *A Wing Tank Transverse Bulkhead*

3. Lift bulkhead.

   As the crane raises the bulkhead, tipping it upright, the load must be centralized at all times so that the bulkhead will not swing when raised clear of the ground.

4. Signal crane operator to take bulkhead to place of erection.

5. Lower bulkhead into position, using spud bars to guide it in between the shell longitudinals.

6. Connect two clip angles, each with three bolts, "c", Fig. 98, at top connection.

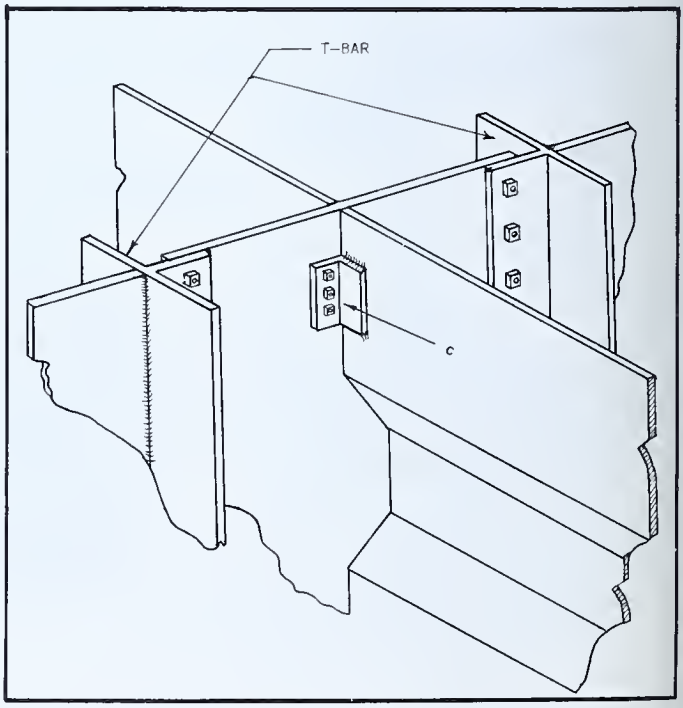


FIG. 98 — *Wing Bulkhead Erection Clip*

   Insert a bolt in each of these holes and pull tight.

7. Connect two clip angles at bottom, using bolts.

   If the bottom of the bulkhead extends out from one-half to one inch it can be aligned by the regulators, who place a hydraulic jack on the bottom shell and push the bulkhead into place. See "b" Fig. 95.

8. Unhook crane.

9. Take tools and equipment to next job location.

QUESTIONS

1. What is a wing tank transverse bulkhead?
2. How is this bulkhead turned to an upright position?
3. What precaution must be exercised in erecting this assembly?
4. How is a bulkhead guided in between the shell longitudinals?

JOB SHEET NO. 10
ERECTING SIDE SHELL ASSEMBLY SECTION

General Information

The side shell assembly sections include the shell plates F, G, H, J and K, two side shell frames, and the side shell longitudinals Nos. 1 to 13 inclusive. These sections weigh approximately twenty-eight tons or more.

This assembly is raised from the ground by procedures similar to those used in handling the bulkheads in preceding jobs.

Tools and Materials	Equipment
1. Bars	Pennants
2. Maul	Shackles
3. Bucket of $\frac{7}{8}$" and $\frac{3}{4}$" bolts and washers	Shackle bolts Safe capacity of 28 tons
4. Step cut dogs	Ratchet
5. Steel wedges	2 cranes
6. Clip angles with bolts	

Additional Mechanics Needed: Regulator and welder.

Procedure

1. Locate shell section by means of the frame numbers and port or starboard markings.
2. Shackle pennants to lifting pads.

   The proper declivity for the piece is secured by using either the shackle or the wheel strap, whichever is necessary to secure the proper amount of declivity.
3. Lift bulkhead and move to place of erection.

   In moving these sections into place be extremely careful of the staging towers, spawls and planks.

   Since these sections do not hang in a vertical position when hooked to the crane, they sometimes present a difficult job in getting them into place owing to the small amount of space between the two bulkheads and the staging towers.

   If clearance does not permit moving side shell assembly into position owing to stage towers, staging, etc., the following procedure may be employed.

   a. Swing side shell assembly "a", Fig. 99, into position before erecting wing bulkhead, "b". Side shell assembly "a" will remain in this position, supported by crane.

   b. Swing wing tank bulkhead, "b", Fig. 99, into position with a second crane.

   c. Erect and bolt the wing tank bulkhead "b" into position, and unshackle crane from wing tank bulkhead.

   d. Erect side shell assembly "a", that had been swung into position, and was supported by a crane. This erection procedure is described elsewhere on this sheet.

4. Match waterlines on transverse wing bulkhead and side shell assembly.

Waterlines on both transverse wing tank bulkheads and side shell assembly are indicated by three center punch marks. So that these marks may be easily located, daubs of white paint are placed above, below, or both above and below the center punch marks.

To align the side shell assembly at a waterline, a line is drawn through both sets of waterline center marks. These lines "aa", Fig. 100 are then matched by raising or lowering the side shell assembly by means of the crane.

5. Match bulkhead set marks on inside shell as-

FIG. 99 — *Erecting a Side Shell Assembly*

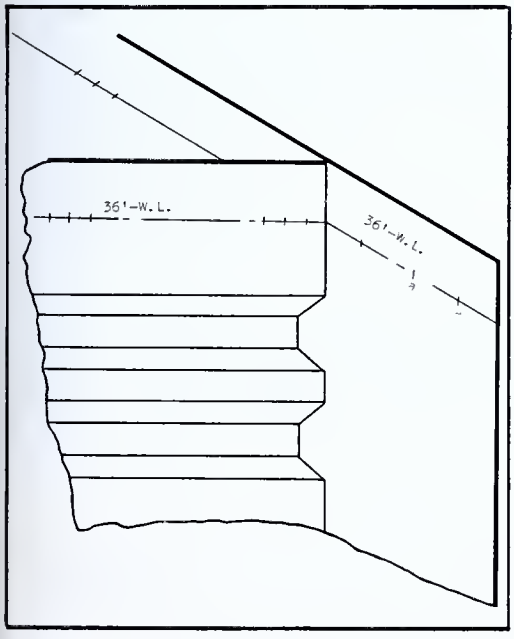


FIG. 100 — *Wing Bulkhead and Side Shell*

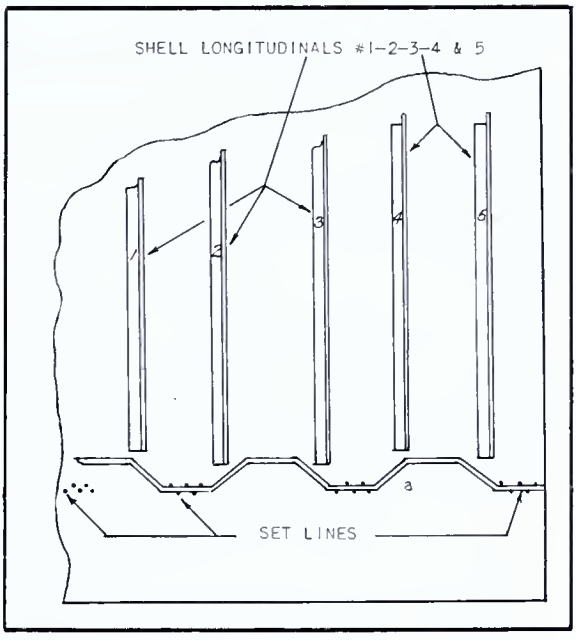


FIG. 101 — *Bulkhead Set Marks on Side Shell Assembly*

sembly with transverse wing bulkhead. Bulkhead "a", Fig. 101 set marks are placed alternately in rows to show the exact alignment of side shell assembly and transverse wing bulkhead. The side shell assembly bulkhead set marks, "a" are registered by swinging the shell assembly forward or aft by means of the crane. It may be necessary to tilt the transverse wing bulkhead toward the bow or stern to bring the bulkhead set marks in alignment at top and bottom.

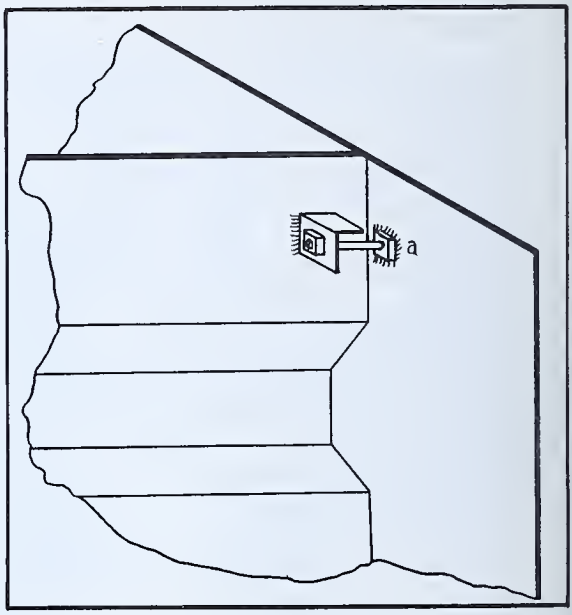


FIG. 102 — *Clip and Bolt Pulling Side Shell to Bulkhead*

6. Fasten the top of the side shell assembly to the top of the transverse bulkhead with a clip and bolt.

   A clip is welded to the bulkhead and the head of a 6″ bolt is welded to the side shell assembly, "a" Fig. 102. Pull side shell and bulkhead together by tightening nut.

7. Pull bottoms of side shell assembly and transverse bulkhead together by use of the ratchet and fasten with bolt and clip, as indicated in step No. 6.

8. Have shipwrights shore the side shell assembly.

   If not properly shored, the weight of the shell assembly will cause the bulkhead to settle.

9. Unhook crane.

Erecting Succeeding Shell Assemblies

The erection of each successive section will be exactly as described, except that from the center midship section towards each end of the ship, the sections are connected to the previous section erected instead of to two wing bulkheads.

QUESTIONS

1. What members are included with the side shell assembly section?
2. How is this assembly raised from the ground?
3. What markings are used in locating shell assembly sections?
4. Describe the procedure used in erecting a side shell assembly when staging interferes with necessary erection space.
5. How are waterlines indicated on this assembly?
6. How is this assembly set on its waterline?
7. Describe the importance of bulkhead set marks in erecting this assembly.
8. What devices are used to pull bottoms of side shell assemblies and transverse bulkhead together?
9. What variation in erection procedure will be followed in erecting side shell assemblies after the first erection is completed?

FIG. 103 — *Erecting Wing Tank Tie Beams*

JOB SHEET NO. 11
ERECTING WING TANK TIE BEAMS

General Information

The wing tank tie beams are made from H-beams. They are termed "tie beams" because they tie the side shell sections to the interior frame work. There are three tie beams to each frame on each side of the ship.

Tools and Materials

1. Bucket of 7/8" and 3/4" bolts and washers

Equipment

Heavy rope sling or light cable choker
Safe capacity for 3/4 of a ton
Pneumatic wrench (knock-knock)

Procedure

The bottom tie beam usually is erected first.

1. Identify and locate tie beams by means of frame numbers and type letter which may be identified from the blueprint.

O. B. — Outboard
I. B. — Inboard
AV/ — Type letter
/51 — Frame Number
P — Port Side
T — Top of beam

Before erecting it is well to sort the tie beams into sets of three, each set containing the three to be used for each frame on the port or starboard side. The sorting of these beams saves much time while erecting.

2. Place rope sling around beam and shackle to a single pennant.

Sling beam so that outboard end of top beam, and inboard end of bottom beam may be balanced.

3. Lift beam and take to place of erection.

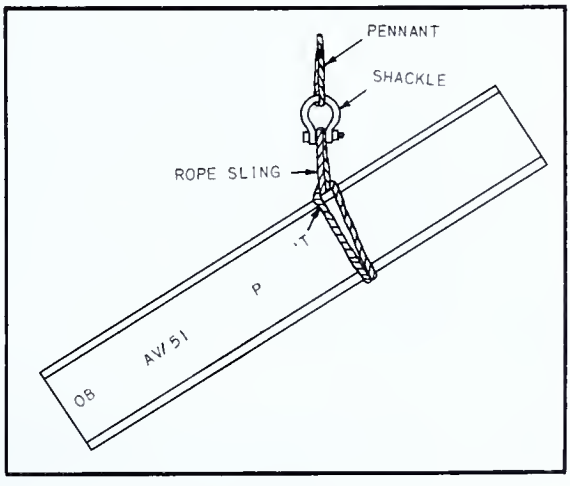


Fig. 104 — *Handling Tie Beams*

4. Fasten each end of beam with at least two bolts.

It is the usual method to connect the bottom end first and then sit on the beam itself while connecting the other end. Each tie beam will be frame numbered so that its proper location is easily identified.

The erectors working on these beams must be men who can climb readily without the use of much staging, since there are very few available footholds.

Tie beams throughout the ship are erected in a similar manner.

QUESTIONS

1. What shapes are used in making up wing tank tie beams?
2. Why are these shapes termed "tie beams"?
3. List identifying and location marks which are important in the erection of tie beams. Explain the meaning of each mark.
4. Why are tie beams sorted into sets before erection?

JOB SHEET NO. 12
ERECTING UPPER DECK SECTION

General Information

The upper deck section assemblies include the upper deck plates B, C, D, and E, the top member of the framing, and the upper deck longitudinals, numbers two to thirteen, inclusive. These sections, as they come from the shop, are in an upright position ready to be erected. On the under side there are two temporary stiffening beams placed across the framework. Before being erected, these ties must be removed.

Tools and Materials

1. Bars
2. Maul
3. Drift pins
4. Bucket of ¾″ bolts, 3″ to 9″ long
5. Pneumatic wrench

Equipment

1. Four hook pennants
   Safe capacity 18 tons
2. Crane

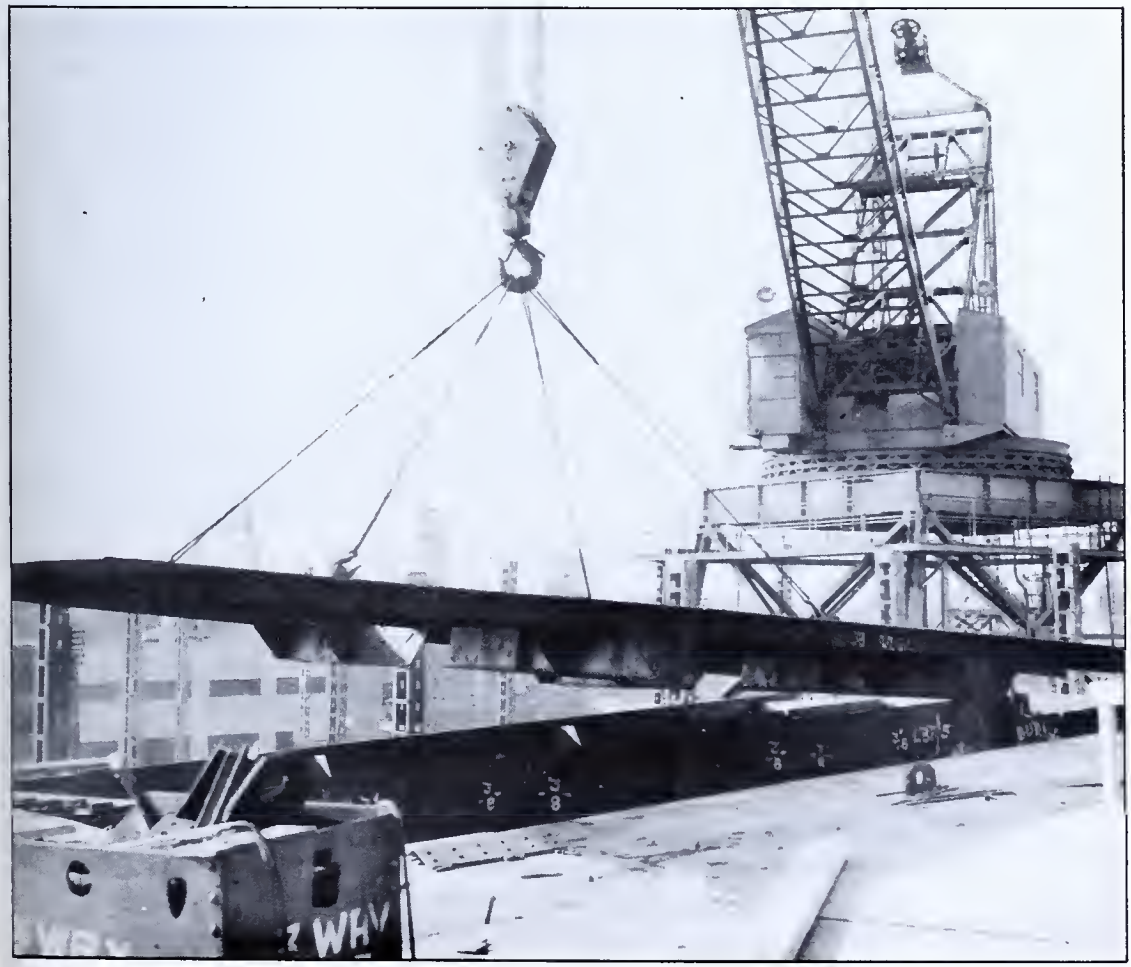


Fig. 105 — *Erecting an Upper Deck Section Assembly*

PROCEDURE

1. Identify and locate upper deck section by means of frame numbers and port or starboard markings. (UDK section 56 to 59 — port)
2. Shackle pennants to lifting pads. See Fig. 105.

   Four welded lifting pads will be placed on the section, so that it will hang in the proper position for erecting. If it does not hang properly, two of these hook pennants should be removed from the crane hook and extended by the use of a large shackle or a wheel strap according to the amount of extension necessary.

   All lifting pads must be removed from the tops of the bulkheads and the side shell sections before the deck sections can be erected. These lifting pads should be returned to the fabrication shops.
3. Hoist deck section into position.
4. Lower section into place.

   When lowering deck sections into place, be sure that the frame connections lap on the proper side of the frames on the bulkheads. See Fig. 106. The correct lap of frames may be determined from the flanges on the frames.

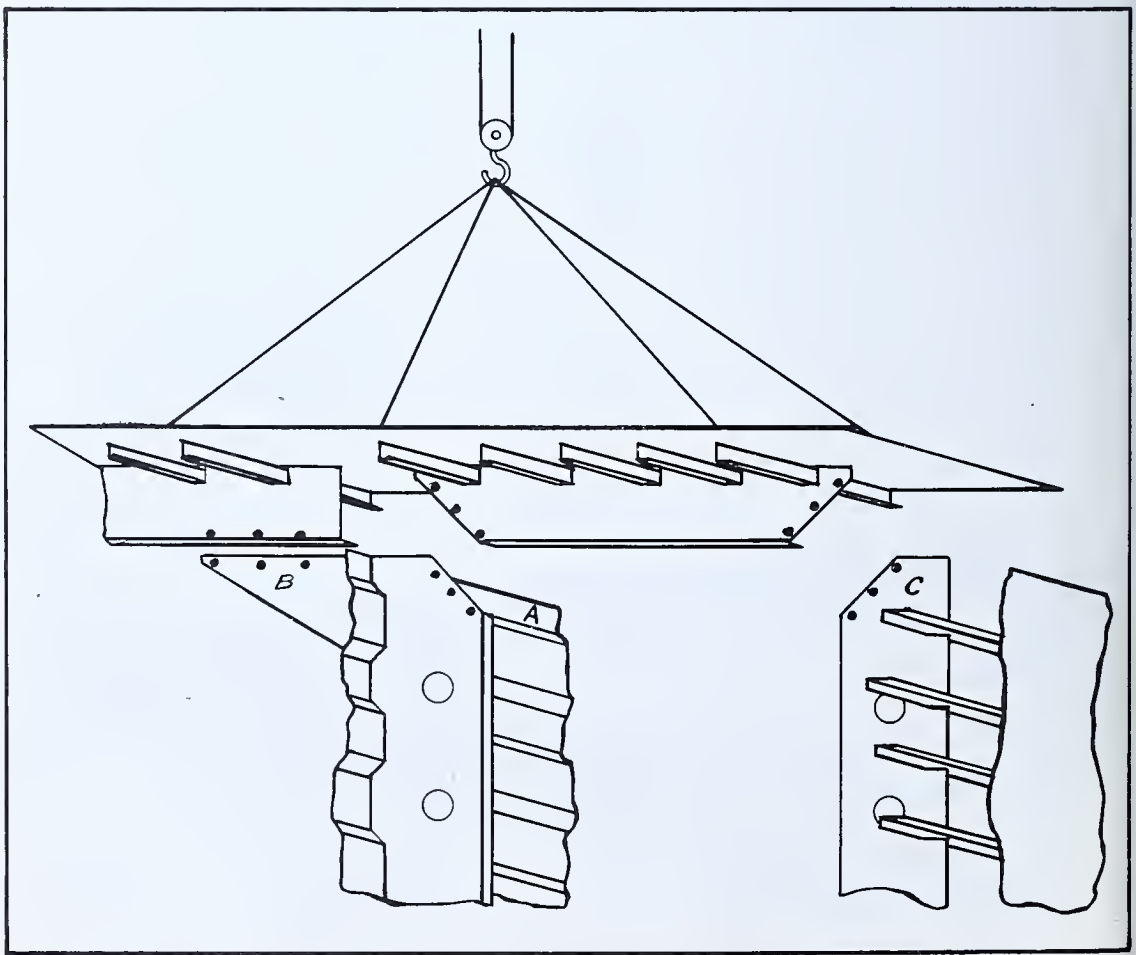


FIG. 106 — *Deck Beam Laps and Upper Deck Sections*

Sometimes, owing to a warped plate, it will be necessary to set a heavy weight on top of the sections to push them down to the bulkhead.

A difficult connection — one badly out of alignment — can be made up by spreading the steel apart and placing long bolts through the holes. See Fig. 107. By tightening one bolt and then another, the connection can be pulled together on the long bolts. When the connection is tight, drift the holes and insert full size bolts.

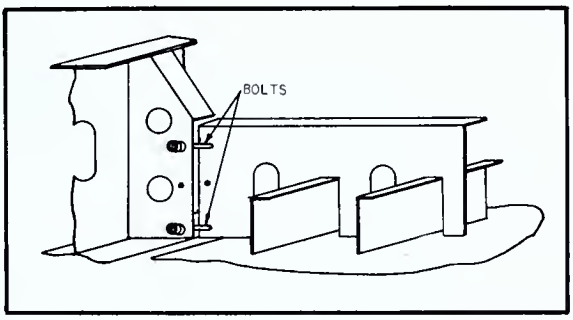


FIG. 107 — *Using Long Bolts to Make Up a Spread Connection*

5. Unshackle pennants.

This section rests on the longitudinal bulkhead "A", brackets "B", and frames "C", therefore, it cannot fall and it is not necessary to bolt it fast to these members. However, it is bolted after the regulating has been done. See Fig. 106.

ERECTING DECK SECTIONS EXTENDING OVER AFTER AND FORWARD ENDS OF A SHIP

The erecting procedure for all deck sections is similar to that described, with the exception of those which extend over the after and forward ends of the ship. On these sections it will be necessary to fasten securely with bolts the frame connections on the under side of the section. A bolt should be placed in all connecting holes.

Since difficulty is sometimes encountered in making up these connections, it is well to use the pneumatic wrench.

When holes do not match properly, drift the holes together by using a drift pin.

QUESTIONS

1. **What members are included in the upper deck section assembly?**
2. **How is the correct lap of frames on bulkheads determined?**
3. **What procedure may be used in pulling warped sections together?**
4. **What variations in erection procedures outlined are necessary in erecting deck sections extending over after and forward ends of the ship?**

JOB SHEET NO. 13
ERECTING AFTER END BOTTOM SHELL PLATING

General Information

The bottom shell plating from the after cofferdam to the stern end of the ship will consist of the flat keel plates, and the A, B, and C plates which will be laid and shored in preparation for the double bottom sections. The laying of the flat keel plates is presented in Job Sheet No. 2. The A, B and C plates will be individual plates, each to be laid separately. See Fig. 111.

Tools and Materials

1. Bars
2. Maul
3. Clip angles with ¾″ bolts
4. Step cut dogs
5. Steel wedges
6. Pieces of flat bar

Equipment

Two ¾″ wire rope pennants
Two shackles
Two shackle bolts
Two screw dogs

Additional Mechanic Needed: Welder.

Procedure

1. Identify and locate bottom shell plate by means of hull number, drawing number, shell plate strake and number, and port or starboard markings. Explanation of marking shown on Fig. 41:

   706 — Drawing number
   3 — After end of the ship
   S. P. — Shell plate
   A — "A" strake
   16 — Plate number (Numbers are consecutive for each strake, beginning at the forward end of the ship).

   The "A" strake plates are laid first along the side of the keel.

2. Weld two pieces of flat bar to the inside, inboard edge of the plate, and one piece on forward inside butt edge of plate. See Fig. 108.

   These flat bars are made to rest on the outboard edge of the flat keel so that they support the inboard edge of the "A" plate during erection.

3. Attach screw clamps to plate and shackle clamps to pennants. See Fig. 109.

   Clamp screw dogs to outboard edge while plate is lying in a flat position.

4. Swing plate into position with crane.

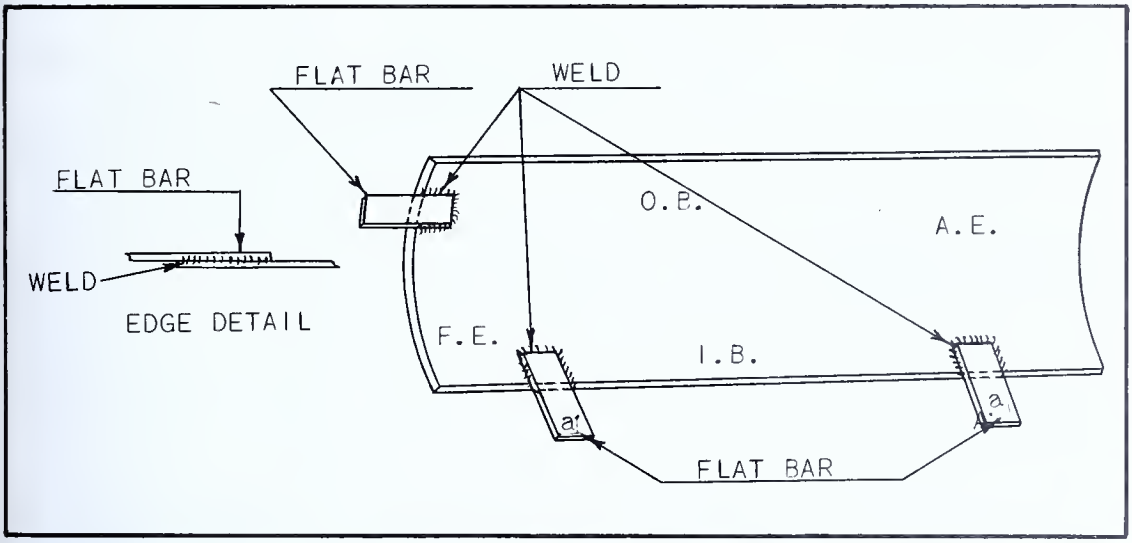


FIG. 108 — *Arrangement of Flat Bar Dogs on Shell Plate for Erecting*

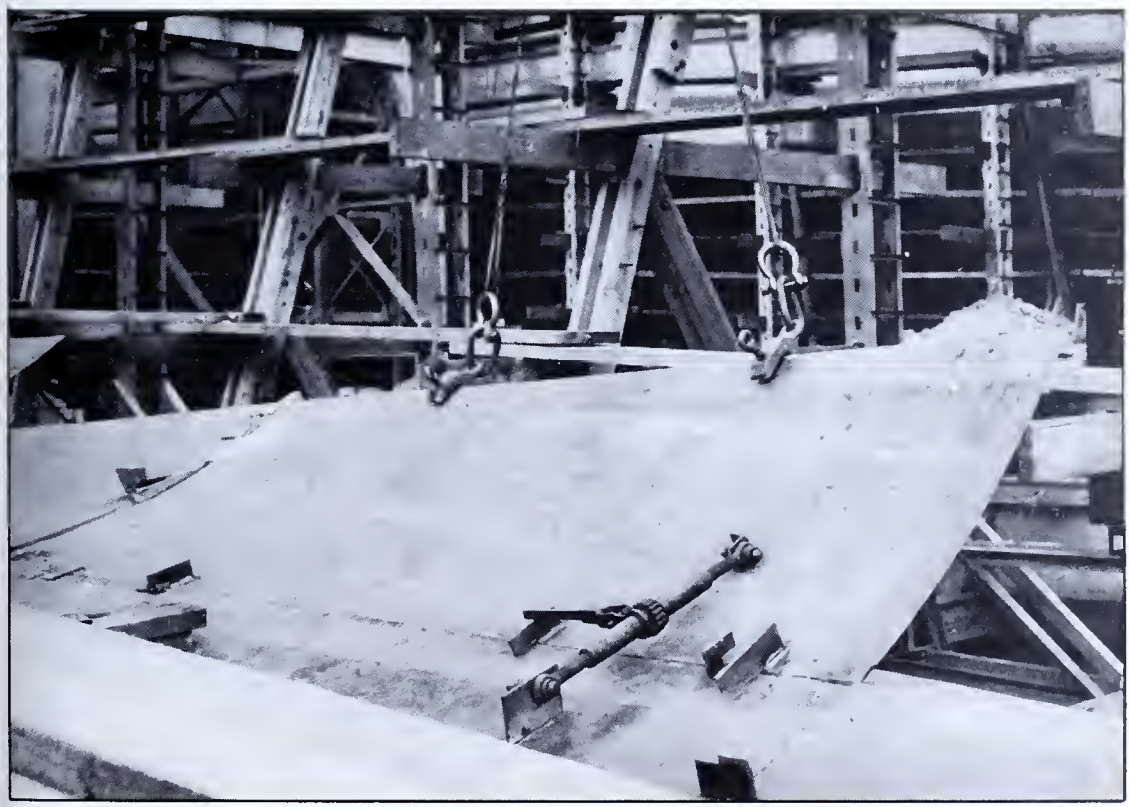


FIG. 109 — *Erecting After End Bottom Shell Plating*

5. Lower crane until outboard edge is at the approximate height needed when erection is completed. See Fig. 109.

The frame set marks on the "A" plate are matched with the frame set marks on the flat keel.

6. Insert welding butt seam spacers.

   Spacers, about ¼″ thick, are placed between the edges of the plate being erected and the adjoining plate, thus providing seam clearance for welding.

7. Have flat bar dogs "a," Fig. 108, tack welded to keel plate and adjoining forward shell plate.
8. Have shipwrights shore plate.
9. Unshackle pennants.

Alternate Method of Handling a Bottom Shell Plate

Instead of attaching pennants to the outboard edge of a keel plate, an alternate method of handling may be employed, as shown in Fig. 110.

Clip angles are welded near the center of the plate as shown, and the lifting pennants shackled to these lifting clips. This method permits picking up the plate in a nearly balanced position, making it more easily handled during erection.

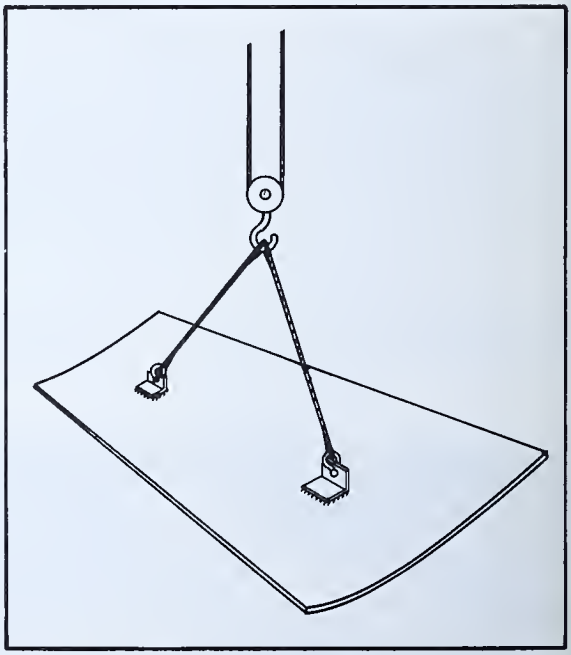


Fig. 110 — *Lifting Clips Welded on Plate for Erecting*

The same procedures are used in erecting and securing the plate as previously described.

All "A", "B" and "C" strake plates may be erected by means of this procedure.

QUESTIONS

1. **What members are included in the after and bottom shell plating assembly?**
2. **What markings are necessary in erecting these plates?**
3. **What set marks must be matched in erecting these plates?**
4. **How is seam clearance for welding provided?**
5. **How are plates held in position and supported?**
6. **Why are clip angles sometimes attached to the center of a plate for handling?**

JOB SHEET NO. 14
ERECTING A DOUBLE BOTTOM

General Information

The double bottom is a structure which strengthens the bottom of the ship and serves as a storage space for fuel oil or fresh water. Also, the double bottom serves as a foundation for the main propulsive machinery.

This structure is called the "double bottom" because it forms two "bottoms," the outer shell plating, and the tank top plating both being watertight. It would be necessary for both the outer shell plating and the tank top

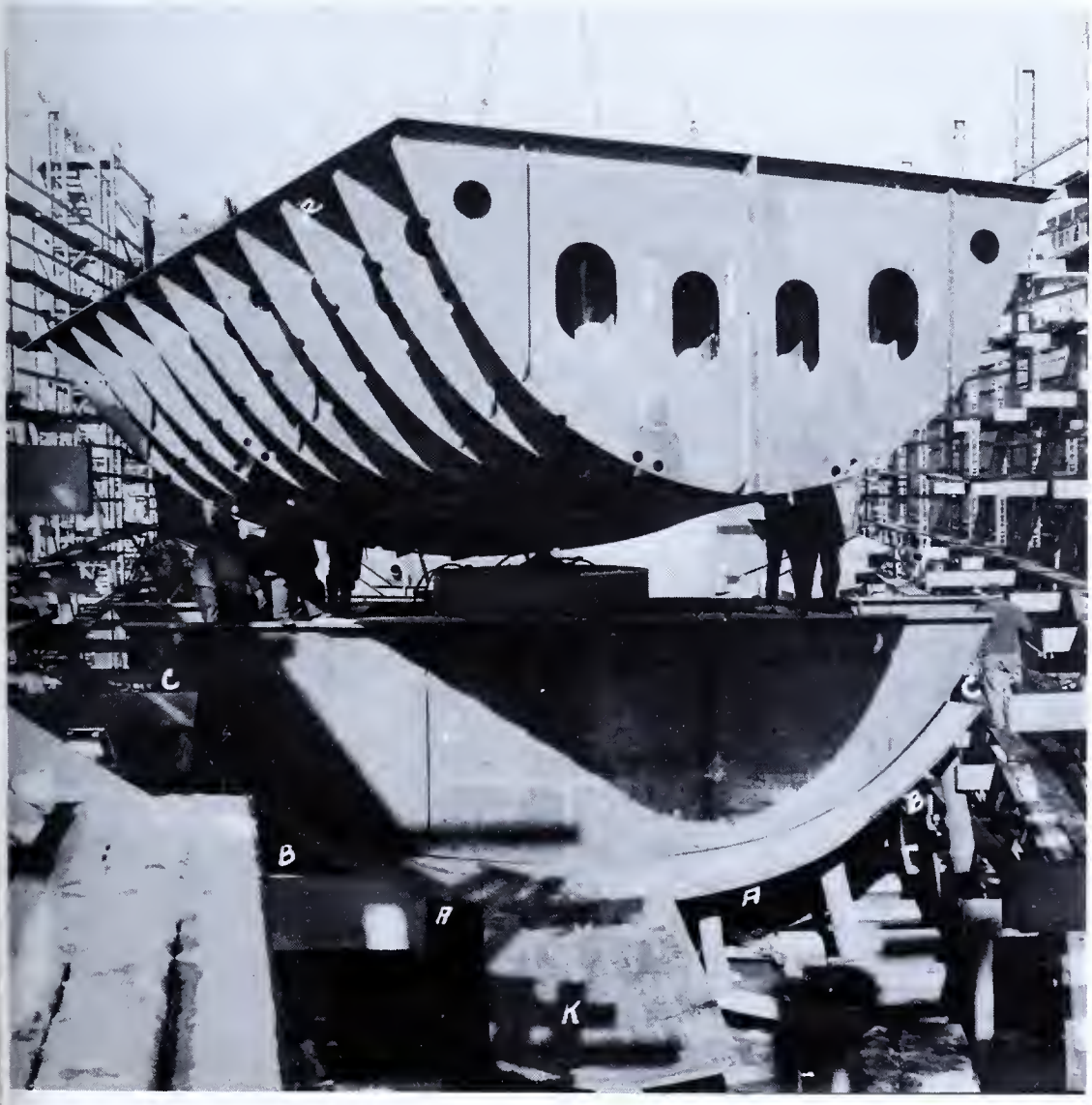


Fig. 111 — *Erecting Double Bottom*

plating (inner bottom) to be pierced before water would be admitted to the engine room.

These sections vary in size, ranging from six- to forty-ton sections.

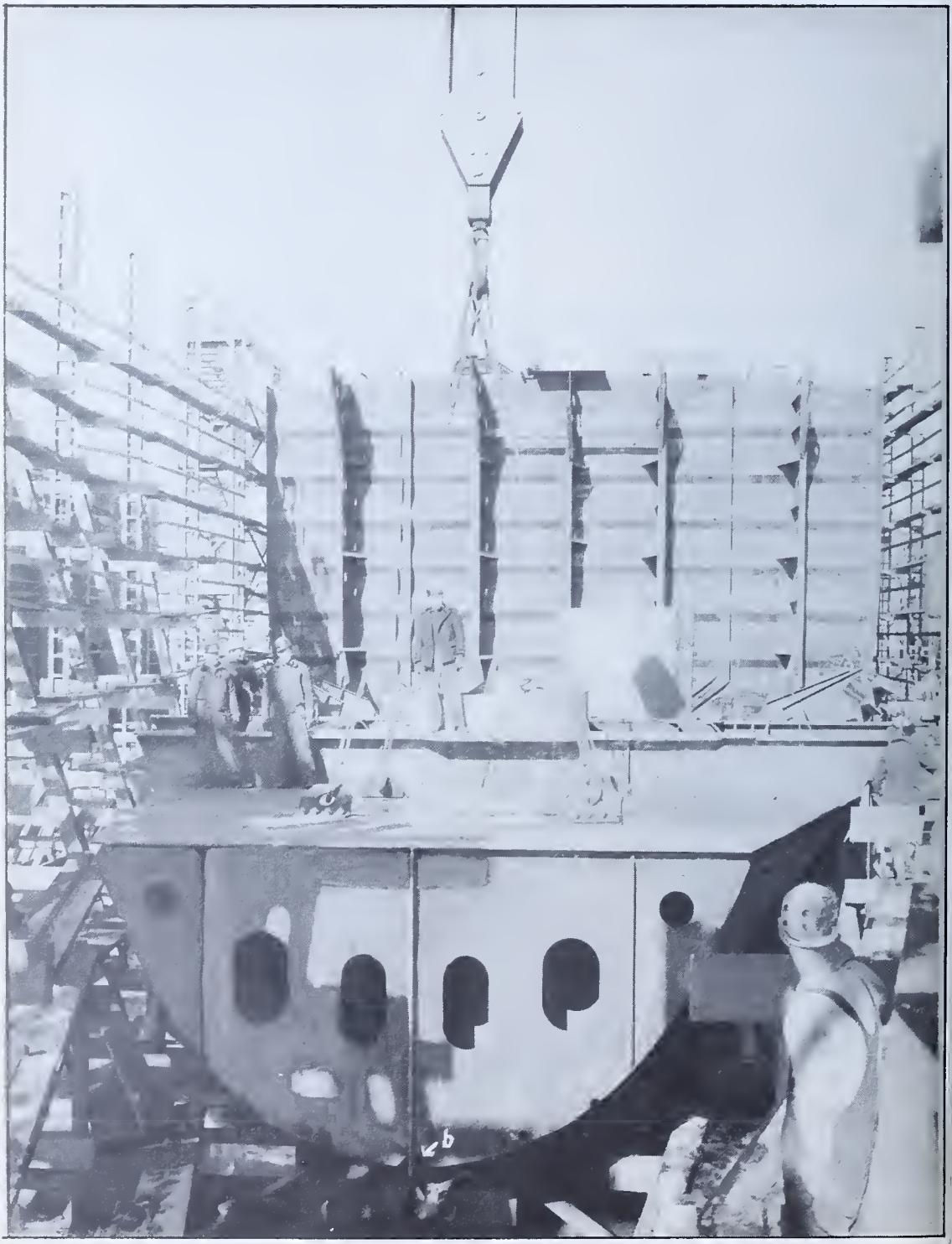


FIG. 112 — *Vertical Keel (of Double Bottom) About to Enter Guide Dogs*

The weight of each piece erected should be known, so that hoisting equipment of safe load capacity may be selected.

Tools and Materials

1. 2 bars
2. 1 maul
3. Erectors' wrenches
4. Twelve 7/8" bolts 8" long
5. Bolts and clips for use with ratchets

Equipment

Four hook pennants 18 ft. long 1¼" wire rope
Two ratchets
Crane

PROCEDURE

1. Identify the location of double bottom assembly by means of extreme forward end frame number and extreme after end frame number.
2. Attach four hook pennants to lifting pads.

   On the top at the tank top plating there will be four lifting pads placed for hooking this section. These lifting pads usually are of the bolted type, containing eight to twelve bolts of 7/8" size in each pad. Inspect these pads before hoisting to see that all bolts are tight and in good condition.

   NOTE: If one crane of sufficient capacity is not available, it may be necessary to use two cranes to lift this section.
3. Signal crane to take section to desired location.
4. See that guide clips are welded to *flat keel plate* at both forward and after ends of double bottom section. See Fig. 112.

   Guide clips are spaced approximately four or five feet apart along the flat keel plate.
5. Lower double bottom section so that the vertical keel enters the guide clips. Each transverse member of the double bottom is a frame. See "e", Fig. 111.
6. Move the crane forward or aft until the required frames register with the frame set marks, "s", Fig. 113, on the flat keel.

   When the first section erected is set down so that the center line and its respective frame markings are in position, it is completed.
7. Unhook pennants.

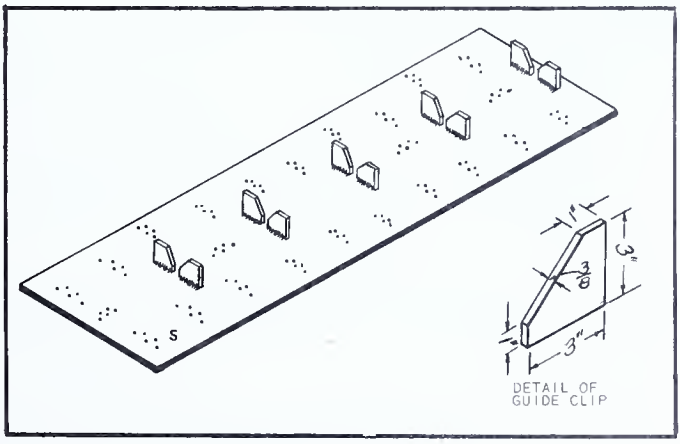


FIG. 113 — *Flat Keel Plate With Guide Clips*

ERECTING SUCCEEDING DOUBLE BOTTOM SECTIONS

Each succeeding double bottom section is bolted to

the previous sections. In pulling these sections together sometimes it will be necessary to use two or more ratchets, since the sections are quite heavy and must be pulled together.

Most connections are butt joints. When pulled together and bolts inserted in the clips welded on each section, the erection is complete.

QUESTIONS

1. **What is the meaning of the term "double bottom"?**
2. **How is the exact location of the double bottom assembly determined?**
3. **Describe the use of guide dogs in erecting this assembly.**
4. **Illustrate the use of set marks in erecting this assembly.**
5. **What holds this assembly in position upon erection?**

JOB SHEET NO. 15
ERECTING STERN FRAME (OR STERN POST) ASSEMBLY

GENERAL INFORMATION

The stern frame is located at the after end of the ship. It is a large casting which forms the hub or bearing for the propeller shaft, and provides a foundation for shaping the after end of the boat. Before being assembled, the stern frame is in three pieces, which are placed together and welded into one complete unit before erecting. Fig. 114 shows the assembled frame, with pennants attached.

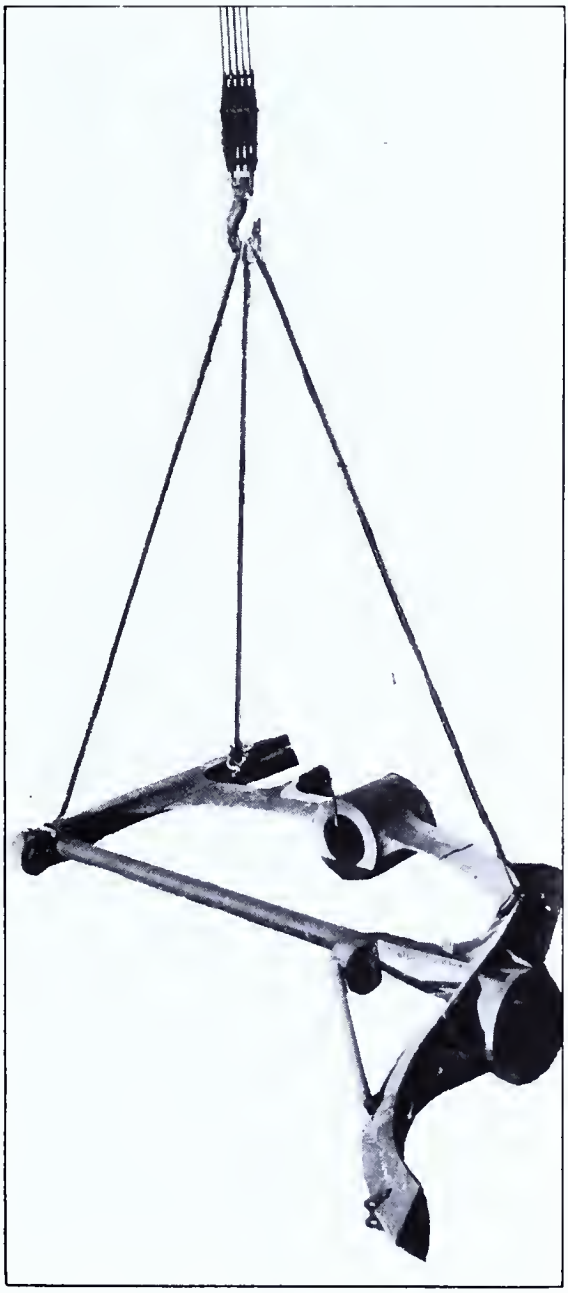


FIG. 114 — *Assembled Stern Frame Ready for Hoisting*

Tools and Materials

1. Bars
2. Maul
3. Three 7/8″ bolts 8″ long
4. Wrenches

Equipment

Three 36-ft. pennants 1¼″ size
Three large shackles with 2½″ diameter bolts
Crane

ADDITIONAL MECHANICS NEEDED: Welder, Burner.

Handling Stern Frame in Yard

PROCEDURE

1. General procedures described in detail in Job Sheet No. 1 are not repeated here.
2. Shackle three pennants to frame as shown in Fig. 114. Two pennants are placed around the casting at the bottom and shackled; the third is placed immediately below the rudder hub at the top of the casting. When raised in this position the

casting may be moved from shipway to shipway without danger of breaking, although it must be handled carefully when lowered to the ground.

3. Signal crane to take frame to location for turning up in erecting position.
4. Lower frame at point of erection, blocking carefully to prevent breakage.

Erecting Stern Frame

PROCEDURE

1. General procedures described in detail in Job Sheet No. 1 are not repeated here.
2. Wrap a thirty-six foot 1¼" pennant around the upper part of the "aperture" of the stern frame, as shown at "a" in Fig. 115.

FIG. 115 — *Stern Frame in Position for Erecting*

For erecting, a 36-foot pennant is wrapped around the casting as many times as its length will permit.

3. Attach crane hook to pennant as shown in Fig. 115. The frame will be resting flat on the ground when the crane hook is attached.

Both ends of the frame bottom are blocked on 12" x 12" x 4'-0" timbers. The frame must be hoisted with care to prevent the frame from slipping from the blocking, with likelihood of breakage.

4. Signal crane to hoist frame into upright position and take to place of erection.
5. Position stern frame for erection.

A center line marking which is placed on the underside of the stern frame is

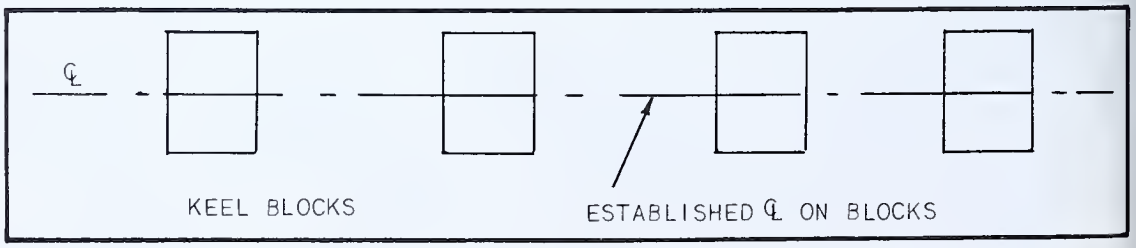


FIG. 116 — *Aligning Stern Frame With Center Line*

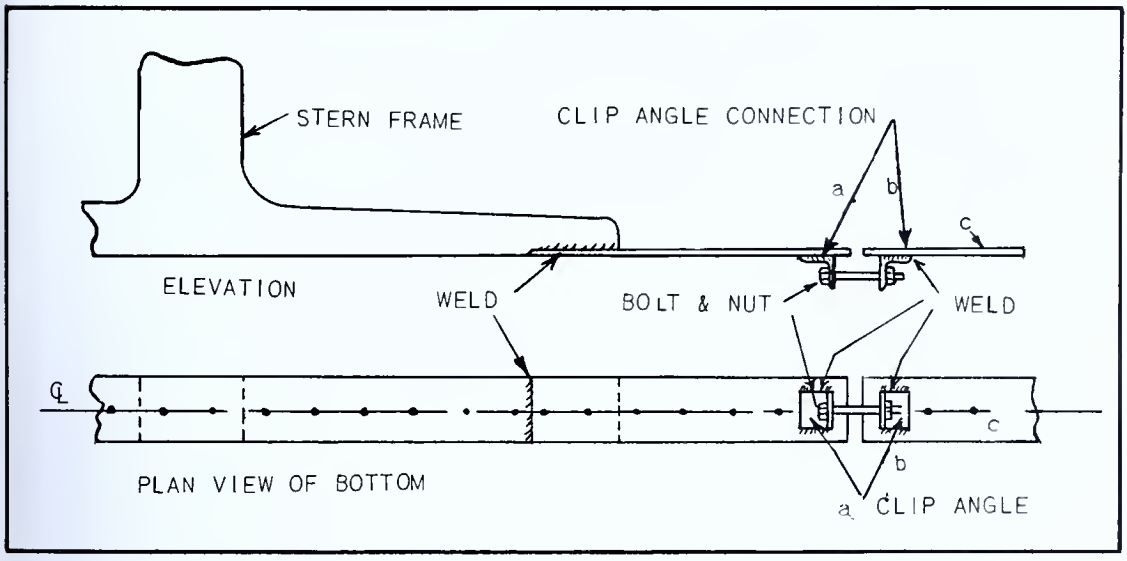


FIG. 117 — *Bolt Clip Connection to Keel*

aligned with the center line on the keel blocks. See Fig. 116.

6. Bolt connecting clip "a", Fig. 117, on forward end of keel plate which is welded to the stern frame, to the connecting clip "b", which is welded to the previously-erected keel plate, "c".

   Three 7/8" bolts, 8" long, will be needed.

7. Have shipwrights install guy lines and shores to properly align the stern frame and to hold it in position when crane is removed.

8. Remove crane after shoring is complete.

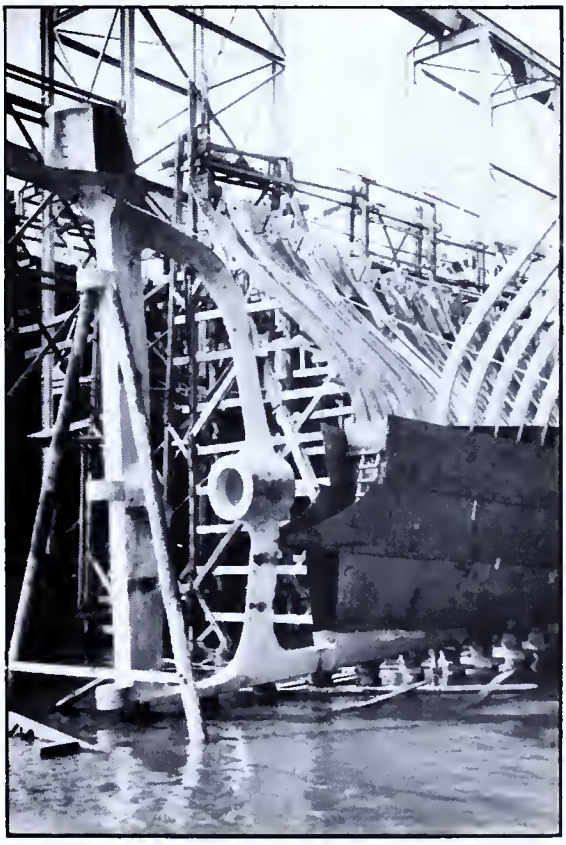


FIG. 118 — *Stern Frame Properly Shored and Guyed*

QUESTIONS

1. Describe how the stern frame may be raised to a vertical position.
2. What care must be exercised in blocking a stern frame?
3. What devices are used to hold the stern frame in position?

JOB SHEET NO. 16
ERECTING ENGINE ROOM STANCHION

General Information

Engine room stanchions, usually of "H"-beam sections, are placed in an upright position to support decks which are placed above them. See Fig. 119.

The erection of each stanchion is similar to that described, except that measurements for locations will differ.

Tools and Materials

1. Bars
2. Maul
3. 12 step cut dogs
4. 12 steel wedges

Equipment

Two ¾″ wire rope pennants 18′ long
Two shackles with shackle bolts

Additional Mechanics Needed: Welder, Shipwright.

Procedure

1. Identify and locate stanchion to be erected.

Each stanchion is erected in an upright position, standing on end. The position of stanchions is determined from frame and buttock markings. Sometimes measurements will be necessary to find the proper location; "8 fwd. of frame 28", may be the measurement given for the frame setting; the buttock measurement may be given as "14′ 2″ off center line." When these two measurements are located, the position of the stanchion is established at this measurement, the stanchion being set on this established mark.

Fig. 119 — *Engine Room Stanchion*

The center line of the stanchion, which is an "H"-beam shape, is found by projecting a perpendicular from both sides of the stanchion, as shown in Fig. 120. The center "a" of the stanchion is erected over the stanchion location, X, in Fig. 121.

2. Shackle pennant to hole in top of stanchion, as shown in Fig. 122.

Shackle pennant to a rivet hole, if holes have been punched. If there is no hole in the top end of the stanchion, burn a hole "a", Fig. 122, for the shackle bolt.

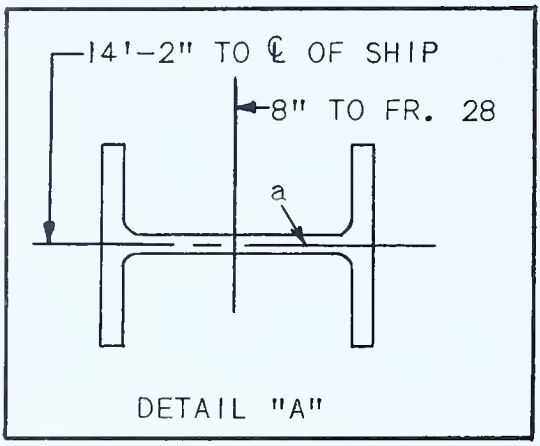


FIG. 120 — *Locating a Stanchion*

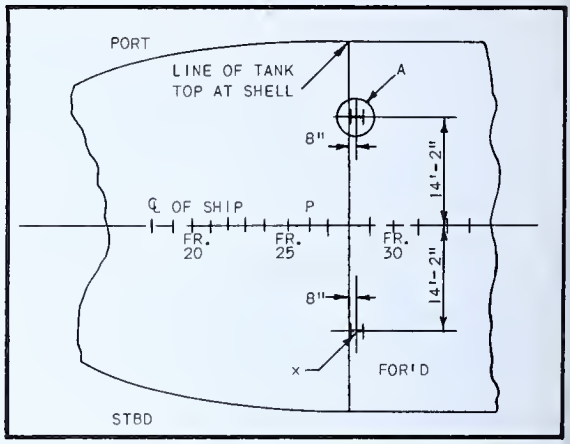


FIG. 121 — *Plan View of Stanchion Locations*

3. Signal crane to hoist stanchion into place.
4. Position base plate of stanchion on location marks established in step "1".
5. Temporarily fasten one side of the base plate "r" as shown in Fig. 122 to the tank top plating.
   a. Have welder attach step cut dogs "n", Fig. 122.
   b. Drive one wedge "o", as shown in Fig. 122. Only one wedge is needed to hold the base of the stanchion in position while it is being plumbed.
6. Plumb stanchion transversely, using a spirit level as shown at "c", Fig. 122.

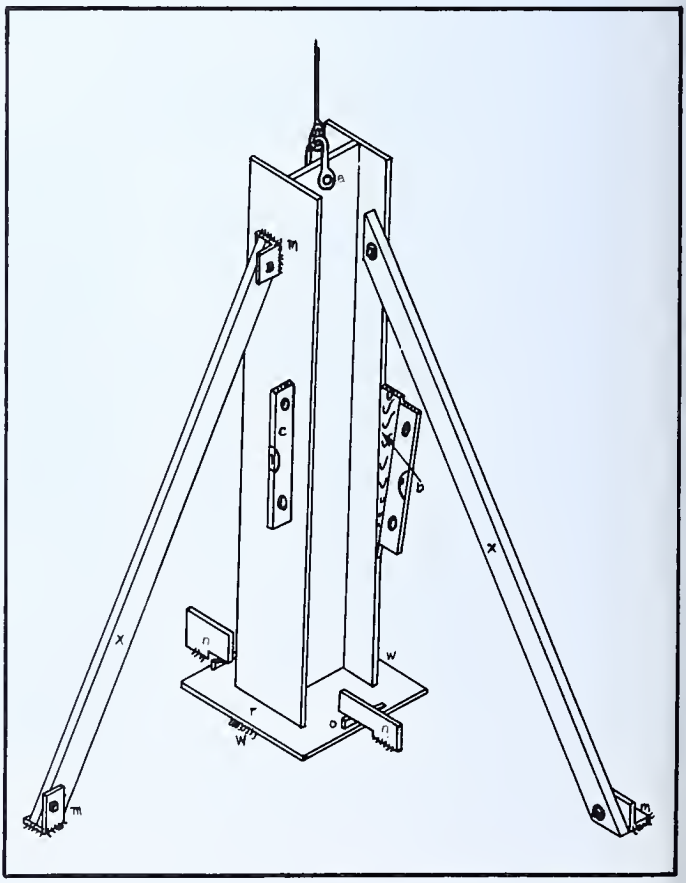


FIG. 122 — *Plumbing and Fastening Stanchion*

NOTE: A ship is level on the ways transversely; that is, from side frame to side frame or from port to starboard. See Fig. 123.

7. Plumb stanchion longitudinally, using a spirit level and a declivity board, "b", Fig. 122.

The top of the stanchion is moved outboard, inboard, forward or aft by changing the position of the crane.

It may be necessary to loosen the wedge, "o", Fig. 122, at the base of the stanchion if the top of the stanchion must be inclined away from the side on which the wedge is placed.

8. Insert the tip of a wedge under the high side of base plate, "r", Fig. 122, and tighten dog wedges.

The side of the base plate which is in contact with the tank top plating is wedged securely, so that the base will not shift position.

9. Attach two braces at right angles to each other about 10′ above base of stanchion.
   a. Weld clips "m", Fig. 122, to stanchion.
   b. Bolt temporary braces "x" to upper clips "m". Braces, about 15′ long, made from 3″ x 6″ plank, are assembled with bottom clips "m".
10. Plumb stanchion.
    a. Athwartship.
    b. Fore and aft.
11. Secure stanchion in position by welding lower clips "m", Fig. 122, to tank top.
12. Tighten wedges under dogs.
13. Have welder place a 3″ tack weld on each side of stanchion base plate, as shown at "w", Fig. 122.
14. Unshackle pennant.

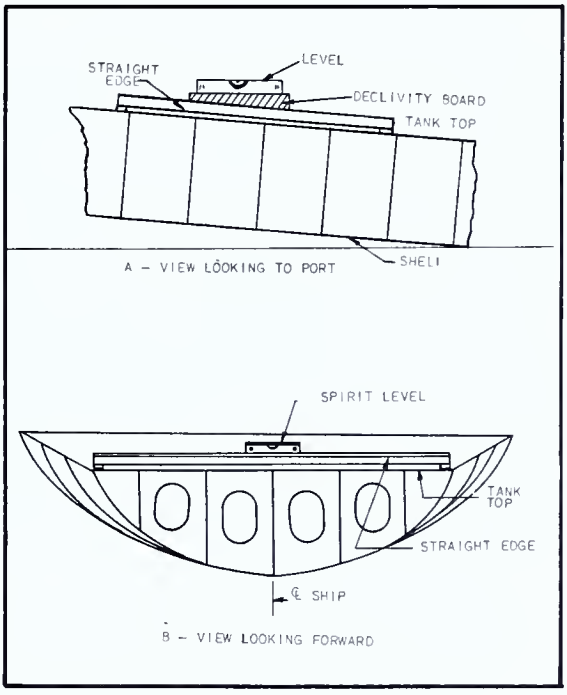


FIG. 123 — *Tank Top Leveled Forward-and-Aft and Athwartship*

QUESTIONS

1. **What structural shape is usually used in making up engine room stanchions?**
2. **What information is necessary in locating engine room stanchions?**
3. **Illustrate how required measurements may be made.**
4. **How is the center line of a stanchion determined?**
5. **Describe how a stanchion with base plate is temporarily attached at the base.**
6. **Describe procedures employed in plumbing the stanchion.**

JOB SHEET NO. 17
ERECTING WEB FRAME WITH SHELL LONGITUDINAL ASSEMBLY

General Information

At the after end of the ship the frame members consist of web frames spaced about twelve feet apart. Into these web frames are placed shell longitudinals which run fore and aft on the shell, about thirty inches apart. Two or three web frames usually are assembled together with their longitudinals and welded into a skeleton-like unit without the shell plates. When erected, this assembly forms the framework for the side of the ship.

Tools and Materials

1. Bars
2. Maul
3. Two dozen guide clips
4. Two dozen 7/8" nuts
5. One dozen steel wedges

Equipment

Two 3/4" wire rope pennants 18' long
Two shackles with two shackle bolts.

Additional Mechanics Needed: Electric welder, shipwright.

Procedure

1. Identify and locate shell longitudinal assembly.

   This assembly is identified by frame numbers placed on the web frames. Each of these web frames will have a number and must be located on its proper frame number on the tank top plating. Each web frame also will have a buttock mark. These buttock marks must be established on the tank top plating before setting the frames. To establish these buttock lines, measurement must be made from the center line of the ship. Port and starboard markings are placed on web frames. See Fig. 124.

2. Have guide clip welded to deck at each frame location.

   Frame set marks "s", Fig. 124, detail "A", are center punched on tank top plating. It is necessary that the shipfitter, or the erector, establish the frame lines "f", using a straight edge or chalk line.

3. Shackle pennants to assembly.

   Pennants are shackled to holes in the top of the web frames at both ends of the assembly, as shown in Fig. 124.

4. Signal crane to take assembly to point of erection.

5. Lower shell longitudinal assembly into position, as indicated by guide dogs.

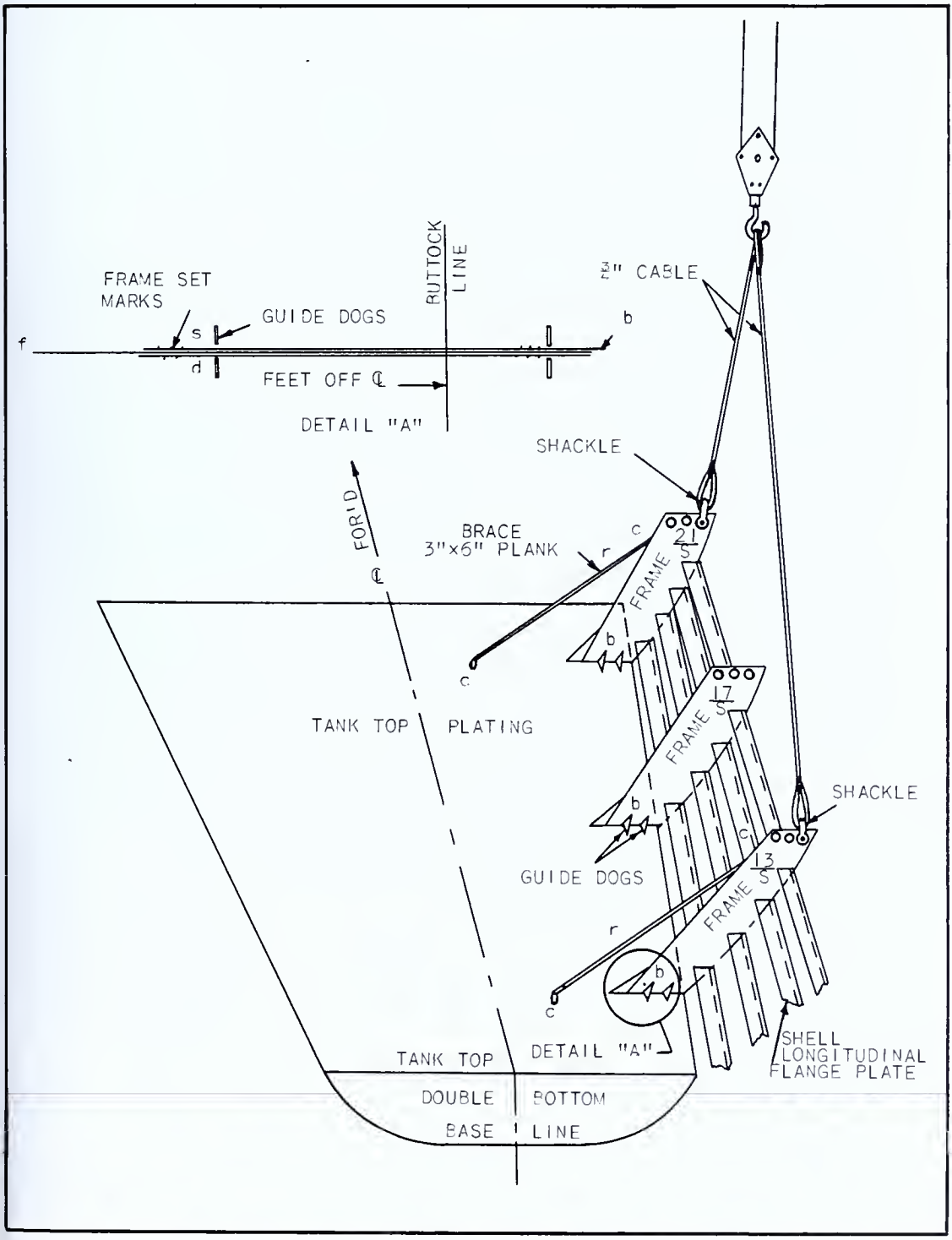


FIG. 124 — *Erecting Shell Framing Assembly*

See that bases of web frames "b", Fig. 124, enter guide dogs "d", Fig. 124, Detail "A", on tank top.

Care must be exercised to prevent breaking stage spawls. If there is insufficient clearance for erection, it may be necessary to have the spawls sawed off.

6. Align buttock marks on web frames "e", Fig. 125, with buttock marks "g", Fig. 125, on tank top.

   Use a pinch bar to move frame assembly inboard or outboard so as to align buttock marks.

7. Tack weld bottom of web frames to tank top, if frames align with frame set marks.

   If one end of a frame is on its marks and the other end is off the marks, the end which is correctly located is tacked. The other end of the frame is then wedged into place by placing a wedge between a guide dog "c" and the frame, as shown in Fig. 126.

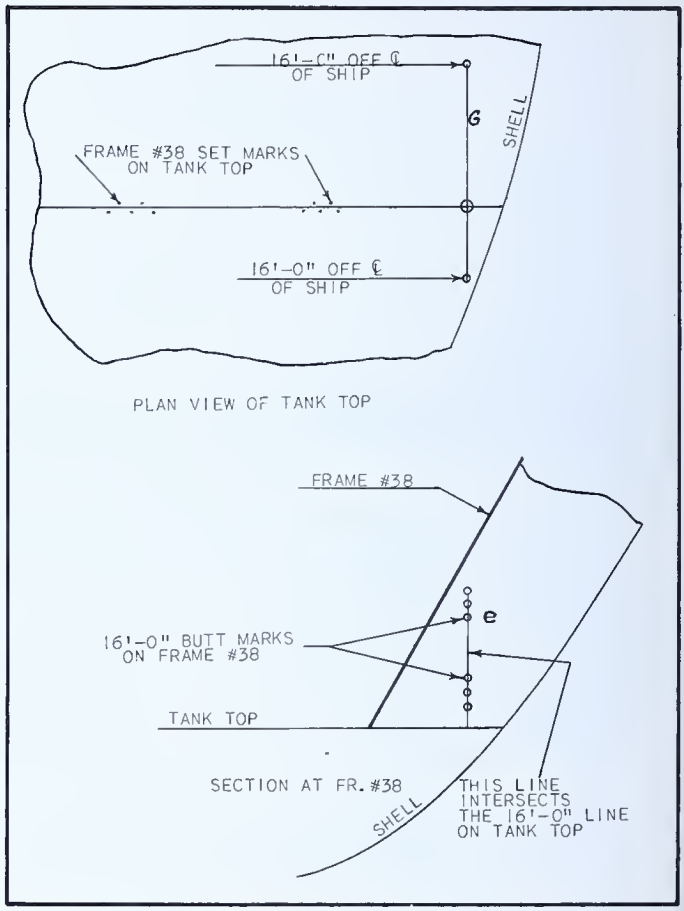


FIG. 125 — *Erecting Web Frame on Buttock Line*

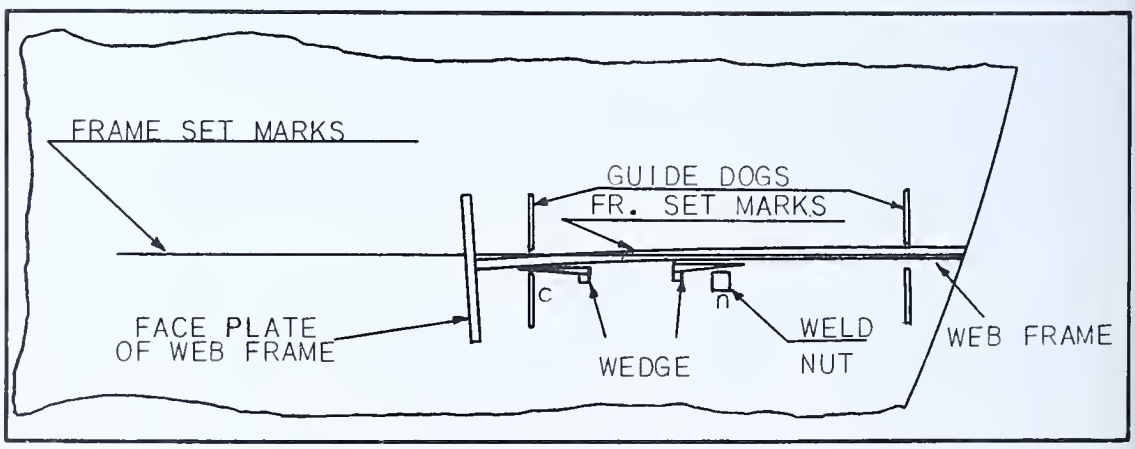


FIG. 126 — *Wedging Base of a Web Frame into Place*

If the base of a web frame is out of position at a point where guide dogs are not attached, a damaged nut or flat lug, "n", Fig. 126 is welded to the tank top. The web frame is forced to its set marks by driving a wedge between the frame and the nut. Any piece of flat scrap may be used in place of a nut.

Each frame is tack welded to the tank top plating as it is wedged into position.

8. Brace frame and shell assembly.
   a. Weld angle clips "c", Fig. 124, to end frames and to tank tops.
   b. Have shipwrights bolt plank braces "r", Fig. 124 to clips "c". These braces firmly support the assembly.
9. Unshackle pennants.

QUESTIONS

1. **What are web frames?**
2. **What members are included in the shell longitudinal assembly?**
3. **How is this assembly identified?**
4. **Indicate location marks which are used in erecting this assembly.**
5. **What are buttock marks?**
6. **How is a web frame forced to its set marks?**

JOB SHEET NO. 18
ERECTING STEERING GEAR FLAT ASSEMBLY

General Information

The steering gear flat assembly is located at the after end of a ship. It extends from the after bulkhead back over the stern post, and is used as the foundation for steering engine equipment. This flat is built up to include the deck plating of the flat, and most of the framing members below it which fit to the stern post.

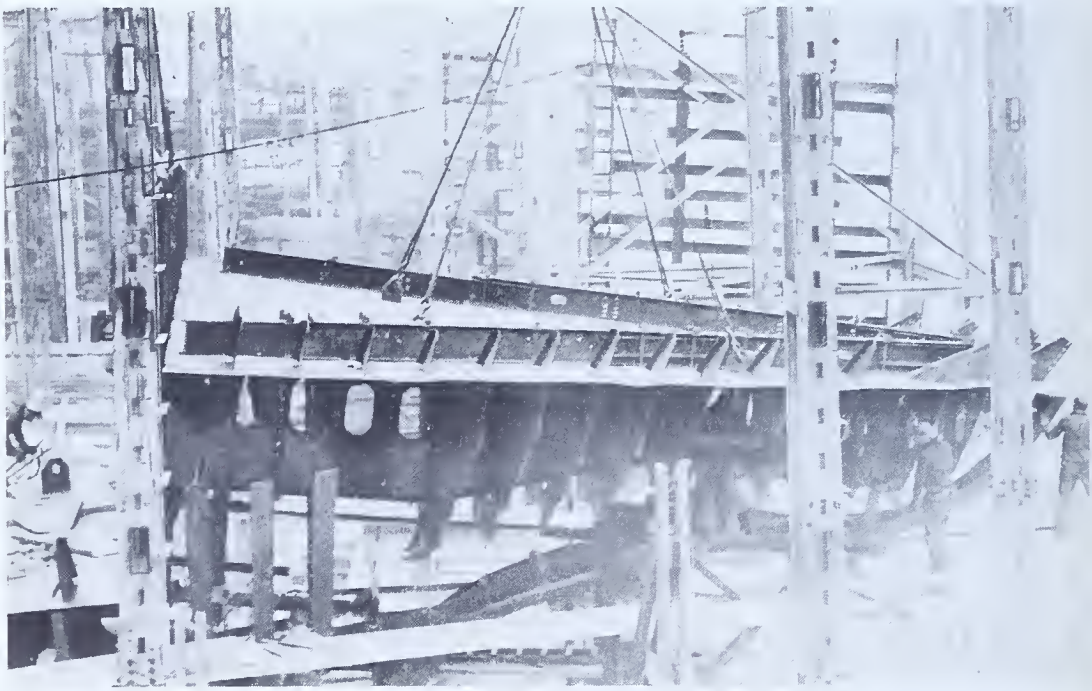


Fig. 127 — *Erecting Steering Gear Flat Assembly*

Tools and Materials

1. Bars
2. Maul
3. Twelve ¾″ bolts, nuts and washers
4. Eight ⅞″ size bolts 8″ long

Equipment

Four 18′ hook pennants 1¼″ wire rope
Two ratchets with clips and bolts
Crane, 15 ton capacity

Additional Mechanics Needed: Electric welder, burner and shipfitter.

Procedure

1. Identify and locate steering gear flat assembly. This assembly is marked: "Hull Number....." and "Steering Gear Flat." The exact location of this

assembly on the ship is determined by steering gear set marks on the after peak bulkhead, matching of center line on after peak bulkhead and on steering gear flat. It is the duty of the shipfitters and shipwrights to see that the assembly is made level.

2. Attach four hook pennants to lifting pads which are welded to steering gear deck plating, as shown in Fig 127.

   The steering gear assembly should be handled in a level position or with the stern end slightly lower than the forward end.

3. Hoist section and take to point of erection.

   The assembly is hoisted into position over the stern post.

4. Lower assembly into position over stern frame. See Fig. 127.

5. Position assembly for erection.

   a. Each frame member under the deck must be fitted in on its proper side of the web on the stern post. In doing this it will be well to use extra men, or to use the second erecting gang, until all these frame members are cut in on the proper sides. See Fig. 128.

   b. When the frame members are

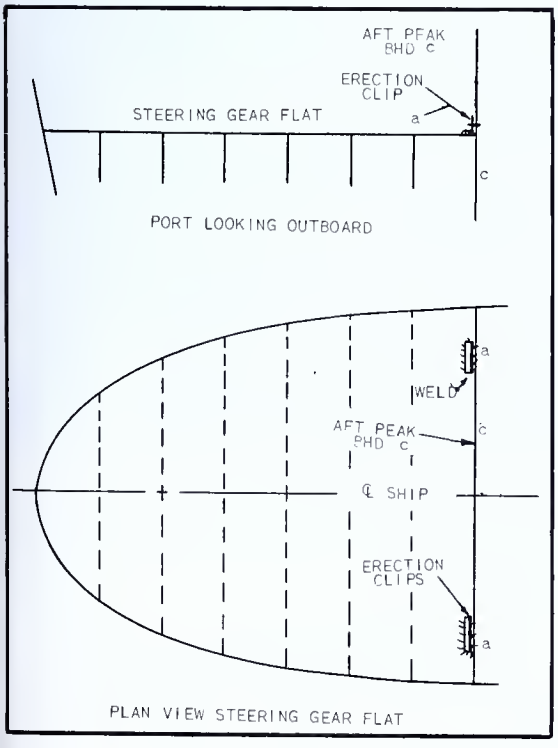


FIG. 129 — *Steering Gear Flat Assembly*

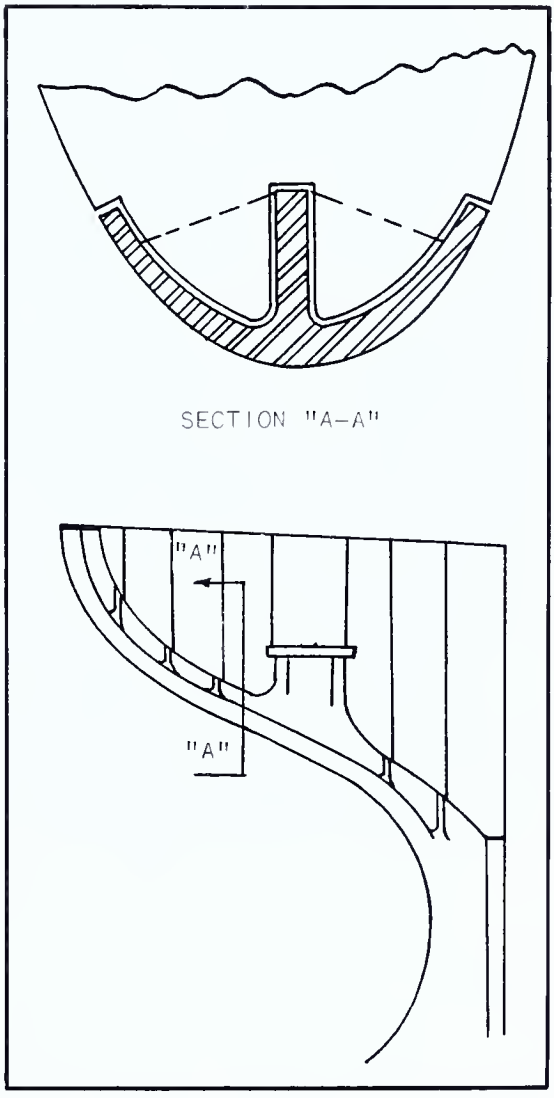


FIG. 128 — *Frame Plates Lapping Webs on Stern Frame*

lowered into place on the stern post it will be necessary to have an acetylene burner cut off any stock metal which keeps the section from coming down into place. Since it may be necessary to burn off each one of these individually, a considerable period of time may be required.

6. Bolt clip connections on top of forward end of steering gear flat "a", to clip connections near steering gear flat set marks on after peak bulkhead "c", Fig. 129.

   This assembly will be leveled athwartship and longitudinally by shipwrights. See Fig. 130.

7. Unhook pennants.

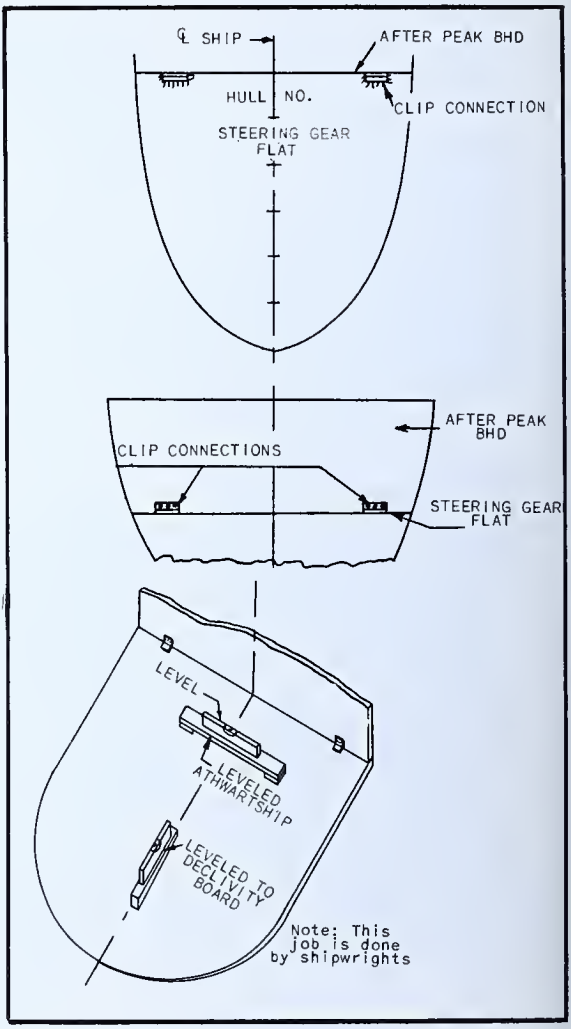


FIG. 130 — *Leveling Steering Gear Flat*

QUESTIONS

1. **What members are included in the steering gear flat assembly?**
2. **What markings are necessary to identify this assembly?**
3. **How is the exact location of this assembly determined?**
4. **Describe procedures in positioning assemblies for erection.**
5. **How is this assembly bolted into position?**

JOB SHEET NO. 19
ERECTING GENERATOR FLAT

General Information

The generator flats, placed immediately below the upper deck at the engine compartment extending along either side of the ship from the after cofferdam to the stern, are used for generator locations, light auxiliaries, and machine shop foundation.

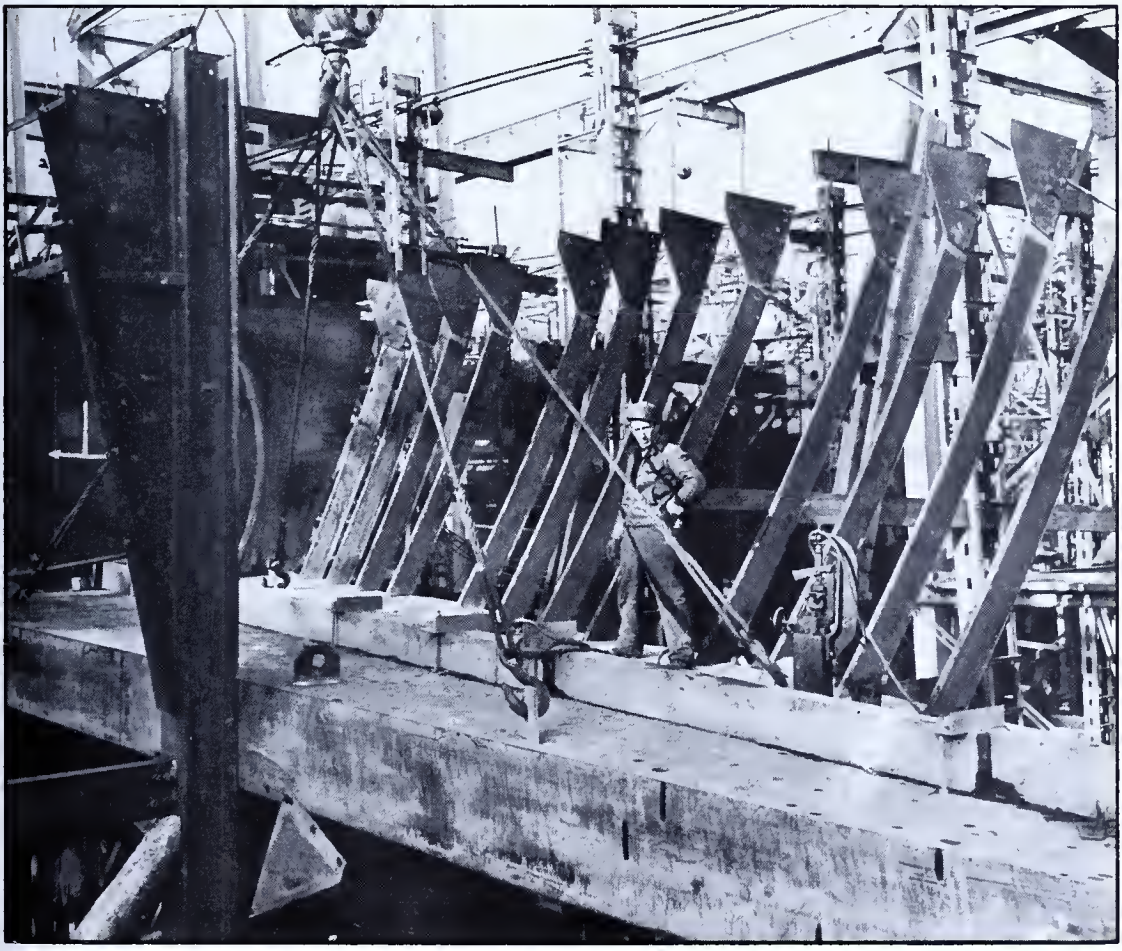


Fig. 131 — *Erecting Generator Flat*

Tools and Materials

1. Bars
2. Maul
3. Erectors' wrenches
4. Twenty-four ¾" bolts & washers
5. Twelve drift pins

Equipment

Four hook pennants 18' long 1¼" wire rope

Additional Mechanic Needed: Burner.

PROCEDURE

NOTE: The forward section of the generator flat is the first of these sections to be erected.

1. Identify and locate generator flat.

   The location of the generator flat is indicated by frame number, and port or starboard markings. See Fig. 131. The forward end of the generator flat will connect to the after cofferdam bulkhead, as indicated in Fig. 132.

2. Attach four pennants to lifting pad.

   Lifing pads are positioned on the generator flat so that it will handle in a horizontal position, as shown in Figs. 131 and 132.

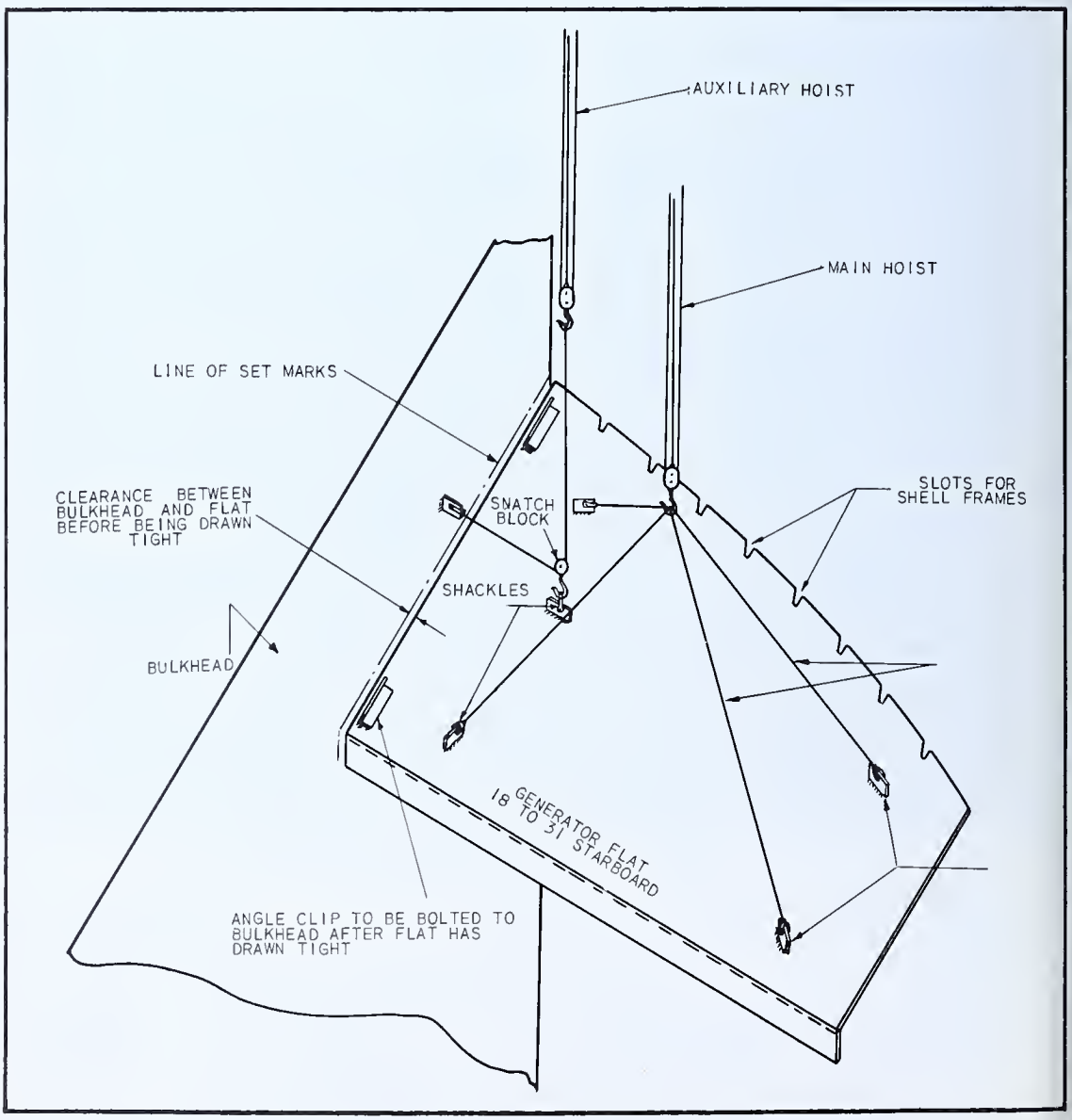

AUXILIARY HOIST
MAIN HOIST
LINE OF SET MARKS
CLEARANCE BETWEEN BULKHEAD AND FLAT BEFORE BEING DRAWN TIGHT
SNATCH BLOCK
SHACKLES
SLOTS FOR SHELL FRAMES
BULKHEAD
GENERATOR FLAT 18 TO 31 STARBOARD
ANGLE CLIP TO BE BOLTED TO BULKHEAD AFTER FLAT HAS DRAWN TIGHT

FIG. 132 — *Using Auxiliary Hoist to Pull Deck to Bulkhead*

3. Signal crane to take generator flat to point of erection.

Each shell frame must enter a corresponding slot on the outboard edge of the generator flat. See Fig. 132. It will be necessary to pry the frames with pinch bars so that all frames will enter their slots.

4. Position generator flat for erection.

The generator flat will rest on top of engine room stanchions, as shown in Fig. 133. This assembly must be aligned with set marks on the cofferdam bulkhead.

If the decks do not hang in the proper position for easy erection, the small hoist of the crane may be used to tip the deck section in any desired position by lowering the small hoist and hooking it to the part of the deck which must be raised. Sometimes the small hoist is used with a pulling hitch to pull the decks tight against the bulkhead as shown in Fig. 132.

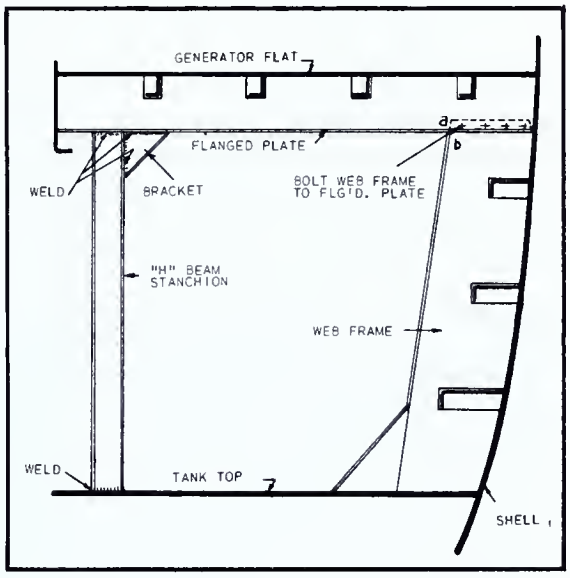


FIG. 133 — *Generator Flat Connection to Web Frames*

5. Bolt forward end of generator flat to clips on cofferdam, using long 3/4" bolts. Holes have been provided in bulkhead, and erection clips welded to the generator flat by the shop.

The pulling hitch, described in step "4" and Fig. 132, is used to eliminate the need for exceptionally long erection bolts.

The flanged plate stiffeners "a", Fig. 133, on the underside of the generator flat must be bolted to the top of web frames "b".

Because the generator flat rests securely on top of the "H"-beam stanchion, no bolted connection is provided.

6. Unhook pennants.

QUESTIONS

1. **What markings are used to identify the generator flat?**
2. **How is the generator flat handled?**
3. **What use is made of bulkhead set marks?**
4. **Why is a pulling hitch sometimes used?**
5. **What connections must be bolted in erecting generator flat?**
6. **How are frames forced into slots in the generator flat at outboard edge?**

JOB SHEET NO. 20
ERECTING ENGINE ROOM CASING BULKHEAD

General Information

The engine casing bulkheads form the sides and the ends of the opening into the engine room of the ship, from the casing top or highest deck level.

The longitudinal engine casings are erected first.

Fig. 134 — *Erecting Engine Room Casing Bulkhead*

Tools and Materials

1. Bars
2. Maul
3. Erectors' wrenches
4. Twenty ¾" bolts and washers
5. Eight drift pins
6. Eight clip angles with ¾" by 6" bolts
7. Bucket of ⅝" x 2" bolts, washers, and nuts

Equipment

Two ¾" wire pennants 18' long
Two shackles
Two shackle bolts

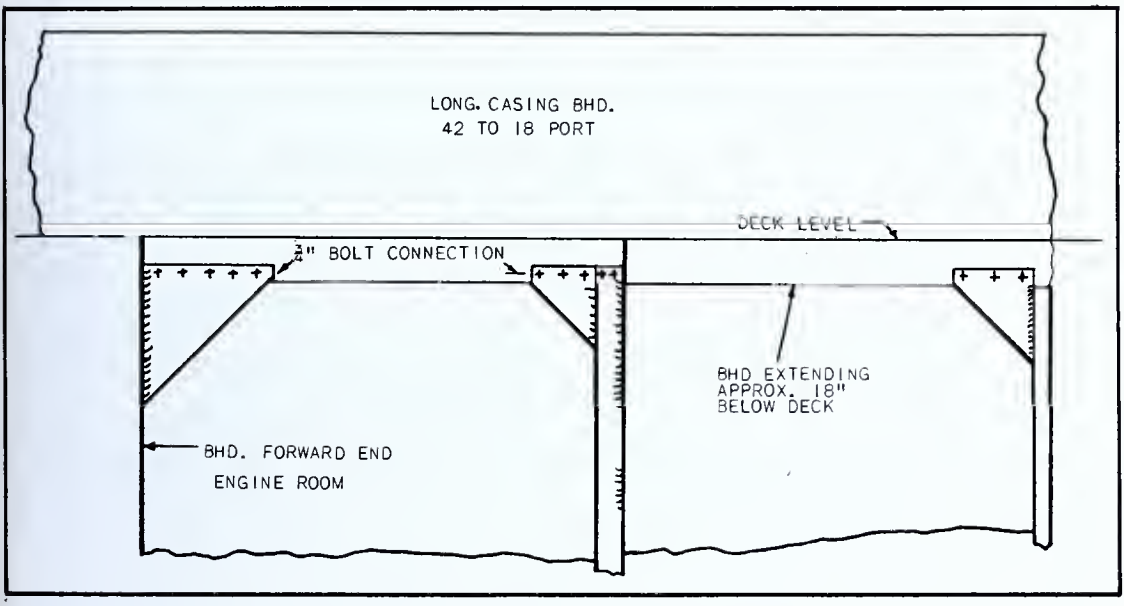


FIG. 135 — *Bracket and Stanchion Arrangement Below Deck Level*

Erection of Longitudinal Engine Casing

PROCEDURE

1. Identify and locate engine room longitudinal casing bulkhead.

   The longitudinal casing bulkhead will be indicated by frame numbers at its extreme ends, and port or starboard markings. See Fig. 136.

2. Shackle two pennants to holes in top ends of stiffeners. See Fig. 136.

3. Signal crane to take bulkhead to place of erection.

4. Position bulkhead for erection.

   The longitudinal casing bulkhead extends about 18" below the deck, as

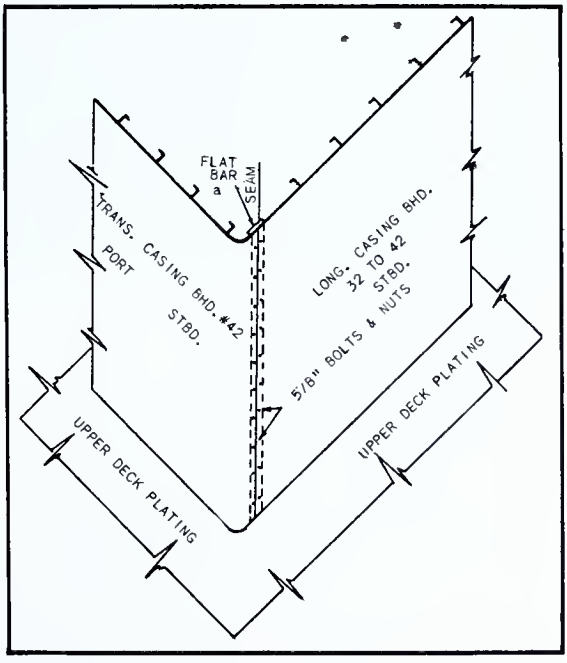


FIG. 136 — *Longitudinal and Transverse Casing Connections*

shown in Fig. 135. Erection bolt holes provided in stanchion brackets and in bulkhead determine the vertical setting of the casing.

5. Secure bulkhead.

   Bolts are inserted in brackets as described in step "4".

   Braces, Fig. 134, must be attached to hold the bulkhead upright.

6. Unshackle pennants.

QUESTIONS

1. **Why are the longitudinal bulkhead casings erected before the transverse casings?**
2. **How is a longitudinal bulkhead casing secured?**
3. **What determines the height to which a longitudinal bulkhead casing is set?**
4. **Why is it unnecessary to use braces to support the transverse casing bulkhead?**
5. **What size bolts are used in making up each connection?**
6. **Indicate meanings of markings, as shown in Fig. 134.**
7. **Is the transverse bulkhead, shown in Fig. 134, the after or forward casing bulkhead?**

JOB SHEET NO. 21
ERECTING SIDE SHELL PLATE — WELDED PLATE METHODS

General Information

Side shell plating at the forward and after ends is built up of individual plates of the all-weld type. No erection holes are included on these plates.

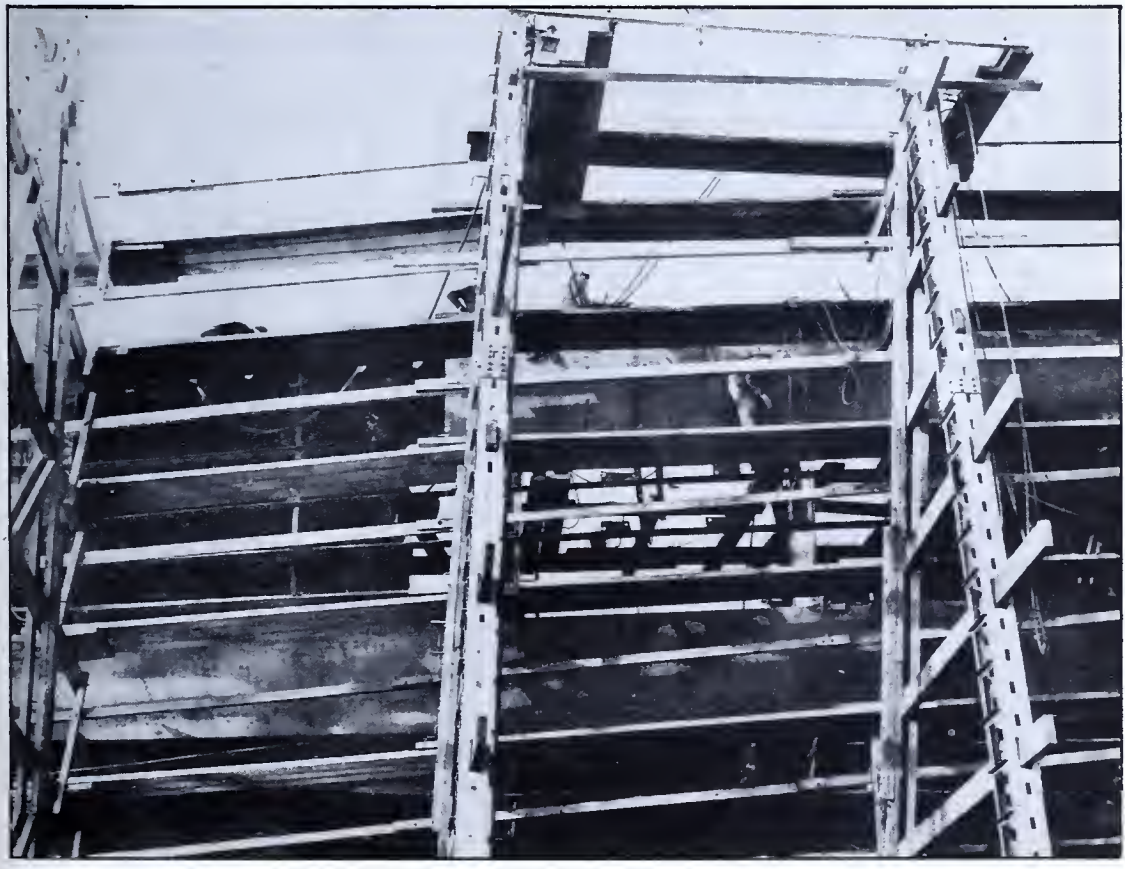


Fig. 137 — *Erecting Welded Shell Plate*

Tools and Materials

1. Bars
2. Maul
3. Two dozen step cut dogs
4. Two dozen U dogs
5. Two dozen clip angles
6. Two dozen 7/8" bolts 8" long
7. One dozen wooden wedges
8. One dozen steel wedges

Equipment

Two 3/4" wire rope pennants 18' long
Two shackles
Two 3/4" shackle bolts
Two screw dogs
Long 3/4" wire rope 75' long (Shell wire)
Chain Fall
Crane

Additional Mechanic Needed: Electric welder.

PROCEDURE

1. Identify and locate plate.

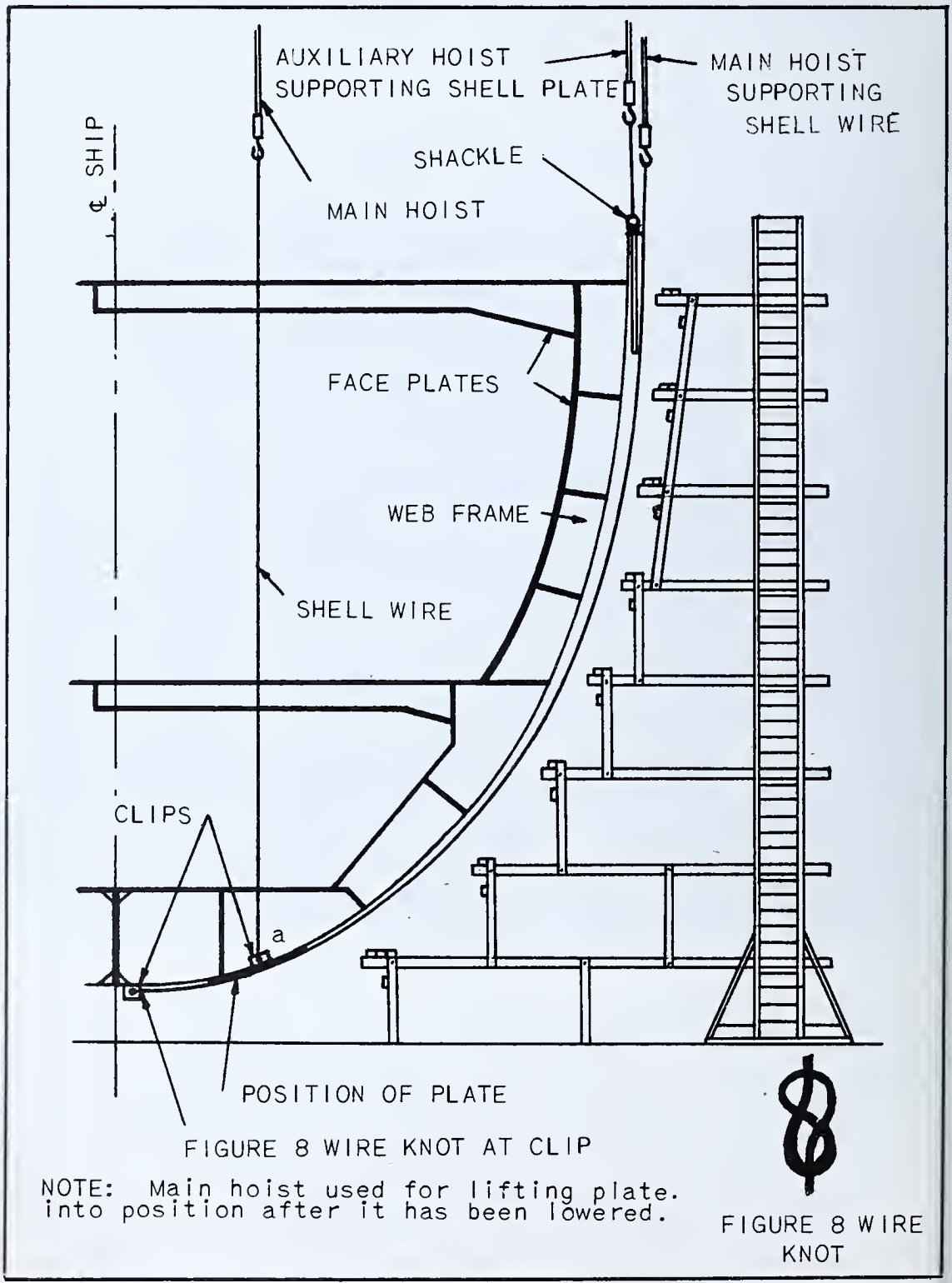


FIG. 138-A — *Lowering Shell Plate into Position on Lower Part of Ship*

Plates are identified by plate number and strake location. The exact location will be determined by the frame numbers. When erecting shell plates at the after end of the ship the D and E plates are usually erected first.

2. Attach two screw dogs to top edge of plate. See Fig. 23-B.
3. Shackle pennants to screw dogs.
4. Signal crane to take plate to place of erection.
5. Lower plate into position.

Since the ship curves inward toward the keel at the lower part, it is necessary to prevent the plates from landing on the staging. This is accomplished by the use of the shell wire. See Fig. 138-B. The shell wire is lowered down the side of the ship and made fast at some point below the strake where the plate is to be erected. When made fast, this wire is placed on one hook of the crane and pulled tight. The plate to be erected is hooked to the other hoist of the crane and then lowered between the shell wire and the ship, so that as the plate slides down the side, the shell wire will prevent the plate from landing on the staging. However, as the plate is lowered workmen must follow the progress of the plate from landing to landing of the staging, using pinch bars to kick the ends of the plate over the stage planks at each landing.

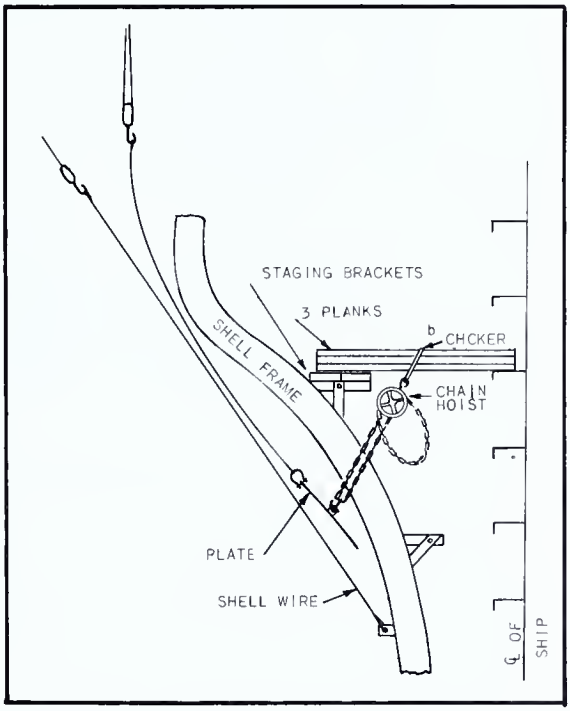


FIG. 138-B — *Pulling Plate to Frames With Chain Hoist*

6. Pull plate into position against frames. Two methods of pulling the plate into position are used; a) use of chain hoist, and b) the shell wire method. See Fig. 138-B.

Chain Hoist Method of Pulling Plate into Position

PROCEDURE

a. Determine best location of chain hoist. Arrange a support for chain hoist.
b. Place three stage planks, as shown in Fig. 138-B, adjusting the ½″ cable choker "b" around planks.
c. Hook chain hoist to eye of choker.
d. Hook end of hoist to lifting pad previously welded on shell plate.
e. Pull plate into position with chain hoist.

Shell Wire Method of Pulling Shell Plate into Position

a. Weld lifting pad "a", Fig. 138-A, to approximate center of plate. The exact position of the pad will be determined by the curvature of the hull at the point of erection of the plate.

b. Attach shell wire (usually a ¾" wire rope) to the lifting pad and to the crane hook.

c. Signal crane to hoist, thereby pulling the shell plate against the frames.

7. Secure plate into position.

Yokes, wedges, clips, and bolts, shown in Fig. 139 are used to pull the plate into final position against shell frames and longitudinals.

These yokes and clips also serve to hold the plate in position after the lifting device has been removed.

8. Remove screw dogs.

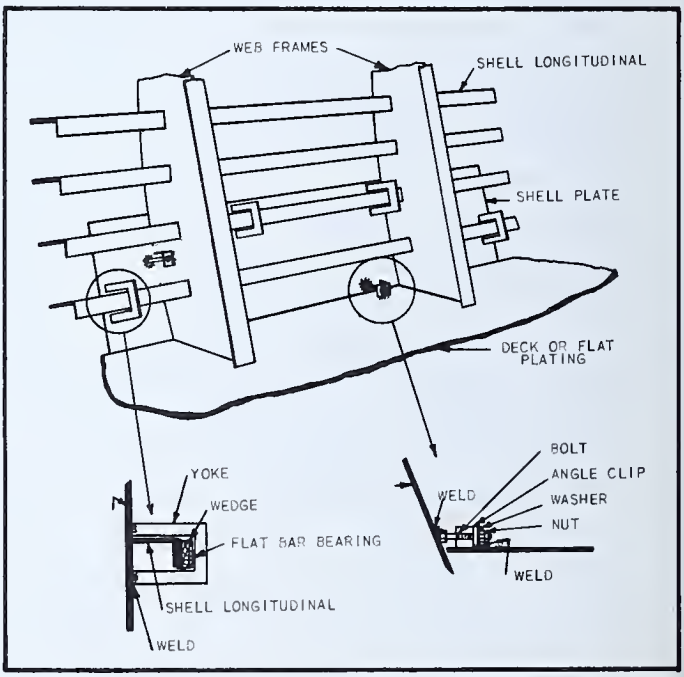


FIG. 139 — *Method of Fastening Shell Plating*

Sequence of Erection of Shell Plates

Shell plates are erected in strakes alternating from port to starboard or vice versa. This is done to eliminate excess weight on one side of ship, which would cause the hull to settle on the heavy side, thereby throwing the hull out of plumb.

In erecting shell plating the regulators closely follow the erectors, regulating each plate soon after its erection.

Figure 140 shows the location of the various strakes of shell plating.

The proper procedure or sequence for erecting shell plating is as follows:

1. Erect "D" strake plates, port and then starboard.
2. Erect "E" strake plates, port and then starboard.
3. Erect "H" strake plates, port and then starboard.
4. Erect "F" strake plates, port and then starboard.
5. Erect "G" strake plates, port and then starboard.

6. Erect "K" strake plates, port and then starboard.

7. Erect "J" strake plates, port and then starboard.

NOTE: "L" and "M" strake plates are erected after poop house bulkheads and deck sections have been erected.

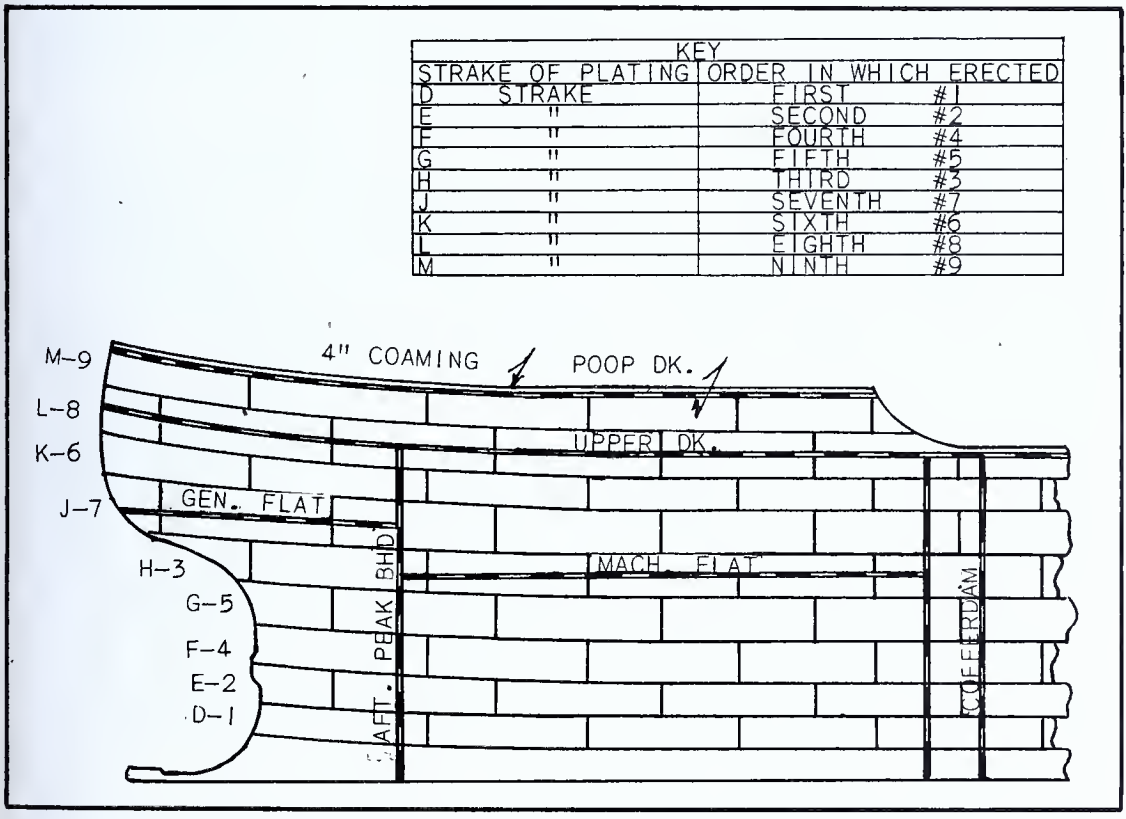


FIG. 140 — *Sequence of Shell Plate Erection*

QUESTIONS

1. **Why is it necessary to use a shell wire in erecting side shell plates?**
2. **Indicate a method of pulling a bottom shell plate against the frames.**
3. **How are shell plates identified?**
4. **How is the exact location of shell plates determined?**
5. **What devices are used to pull a shell plate into final position against frames?**
6. **What sequence is followed in erecting shell plates?**

JOB SHEET NO. 22
ERECTING POOP AND OTHER HOUSE BULKHEADS

General Information

Poop house bulkheads are small bulkheads used as partitions between state rooms, usually of light construction with angle stiffeners. See Fig. 39.

Tools and Materials

1. Two bars
2. One maul
3. 5/8" wrenches
4. Bucket of 5/8" bolts with washers
5. Drift pins

Equipment

Two 3/4" wire rope pennants 18' long
Two shackles
Two 5/8" shackle bolts

Procedure

1. Identify and locate poop house bulkhead. See Fig. 141. To determine the location of each bulkhead it will be necessary to refer to the blueprint of the job. Each piece is type-marked on the blueprint and also on the piece itself, as "plt.A. — Port." When this piece is located on the print, information such as frame number and distance off center line is found from the blueprint. By use of this information the bulkhead is set on its proper location.

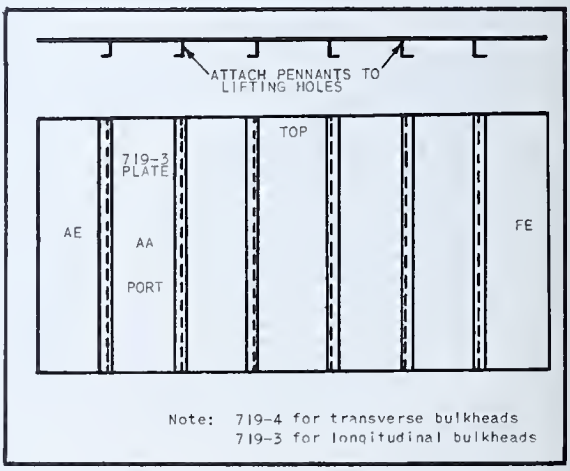


FIG. 141 — *Poop House Bulkhead Marking*

2. Shackle two small pennants to holes provided in top edge of bulkhead stiffeners. See Fig. 141.
3. Signal crane to take bulkhead to point of erection.
4. Position bulkhead for erection.
   a. Determine frame number setting.
   b. Check location of guide dogs. The guide dogs position the bottom edge of the bulkhead so that it aligns with bulkhead set marks.
   c. Check athwartship position of bulkhead from center line.

5. Secure bulkhead in position.

The bulkhead must be supported in a vertical position by braces, attached as shown in Fig. 134.

The guide dogs serve to hold the bottom of the bulkhead in place.

6. Unshackle pennants.

QUESTIONS

1. **How is the location of each poop deck bulkhead determined?**
2. **Indicate the use of guide dogs in erecting this assembly.**
3. **Indicate how this bulkhead must be supported after erection.**
4. **Will the stiffeners be inboard or outboard when this bulkhead is erected?**

JOB SHEET NO. 23
ERECTING POOP DECK SECTIONS

General Information

The poop deck sections, as assembled, include all poop deck plating, all poop deck beams, and such longitudinal girders as may be included without interfering with erecting. They are divided into two sections, one for port and one for starboard.

Tools

Four bars
One maul

Equipment

Two sets of 4 wire rope hook pennants of 1″ size
Two cranes

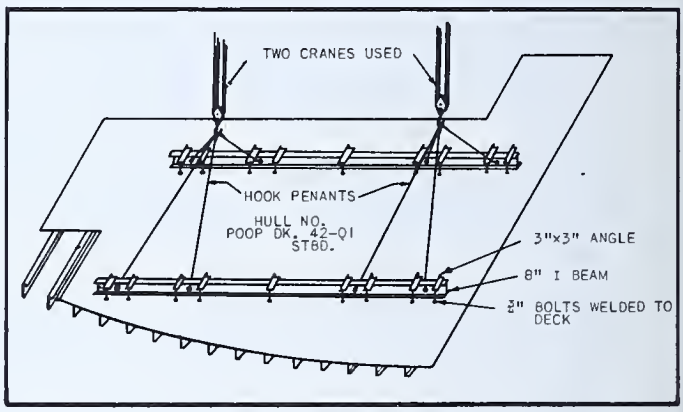


Fig. 142 — *Poop Deck Section Being Erected*

Procedure

1. Identify and locate poop deck section.

   These sections are marked with hull number, extreme frame numbers occurring at both forward and after ends of section, and port or starboard markings. See Fig. 143.

2. Attach hook pennants to lifting holes in temporary stiffeners, as shown in Fig. 142.

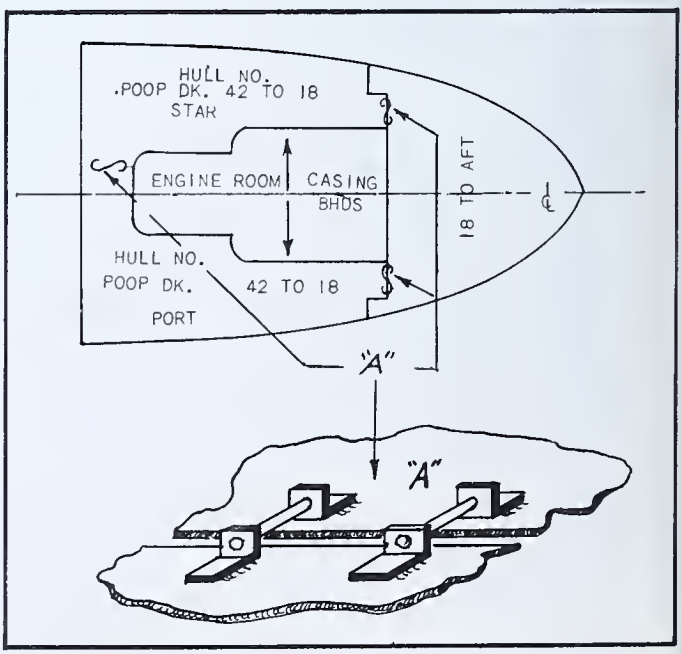


Fig. 143 — *Division of Poop Deck Sections*

The poop deck sections, Fig. 142, because of their length, are hooked on two cranes for erecting, each crane being equipped with four hook pennants which are

fastened to the holes placed in temporary stiffeners. The section is hoisted to its location and lowered onto the poop house bulkheads. Signal crane to carry section to point of erection.

3. Position poop deck section for erection.

The deck section rests upon poop house bulkheads. Along the inboard edge, the sections fit against the longitudinal and transverse casing bulkhead. See Fig. 143.

4. Lower section into position.

All deck beams and girders on the underside of the deck must be placed in the proper slots at the tops of the bulkheads. Some of these will fit into place readily, while others will require force to make them go into their proper places. This force is acquired by the use of a pinch bar. Sometimes a long piece of flat iron or angle iron is used as a lever to pry the beam into its slot. See Fig. 144.

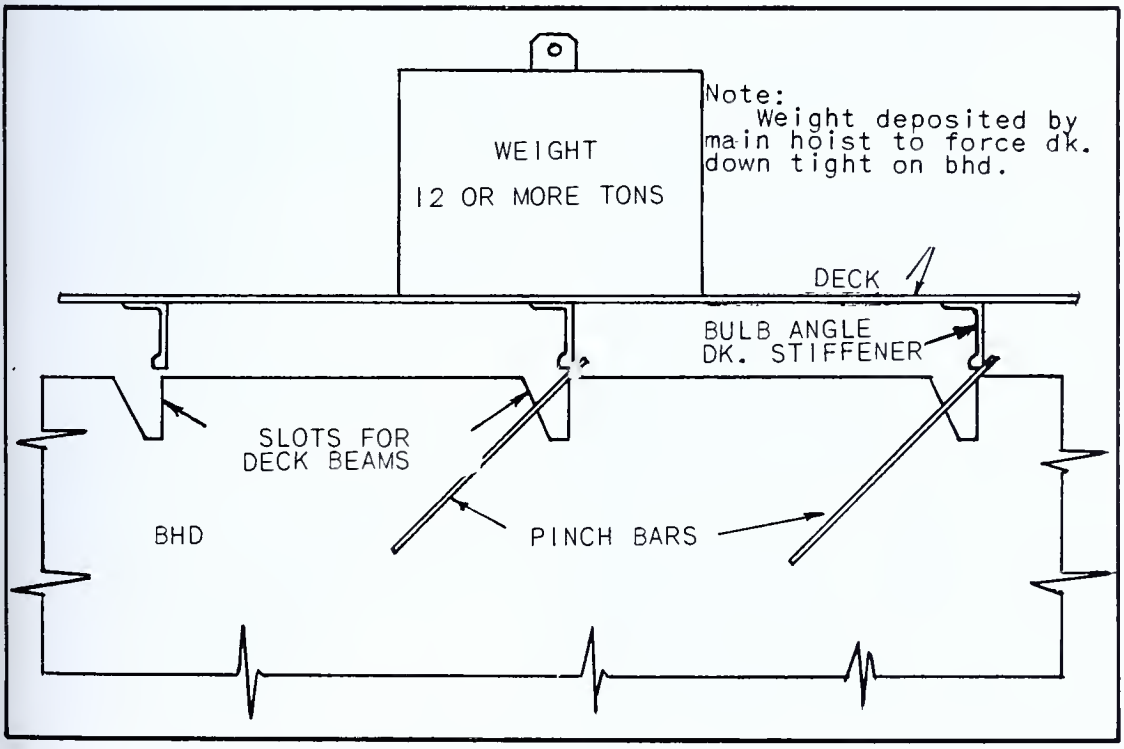


FIG. 144 — *Method of Laying Deck Beams Into Slots in Poop Deck House Bulkhead*

5. Unhook pennants.

6. Force deck section into position by placing a heavy weight on the deck. See Fig. 144.

If the section does not go down into place with its own weight, a weight of from 12 or more tons is used to push the section into place. These weights are used aboard ship to push down humps and high spots and usually are available when needed.

7. Secure deck section in place.

After poop deck sections have been forced into position, the sections are fastened together with welded angle clips and bolts, detail "A", Fig. 143, at points marked "S", Fig. 143.

QUESTIONS

1. **Why must two cranes be used in erecting these sections?**
2. **Describe the procedure used in entering deck beams into the slots of the bulkheads.**
3. **What devices may be used to force deck beams into slots?**
4. **How may the deck section be forced into place?**
5. **What identification markings are placed on these deck sections?**
6. **What difficulty may be encountered in lowering this section into position?**
7. **How are erected poop deck sections fastened together?**

JOB SHEET NO. 24
ERECTING TRANSVERSE BULKHEADS NOS. 72 AND 73

General Information

The transverse bulkheads, Nos. 72 and 73 are, generally speaking, the same as any transverse bulkhead, with the exception that they are divided into two sections at the center line, each section being half of the bulkhead from the center line to the outboard shell plating. These four sections, when assembled, form the forward cofferdam of the ship. Incorporated with bulkhead 73 on the forward side of the bulkhead we also find the pump room bulkheads, the escape trunk from the pump room, and the large brackets which are a continuation of the longitudinal bulkheads. The escape trunk and brackets are slotted to allow the erection of the second deck over the forward fuel oil tank.

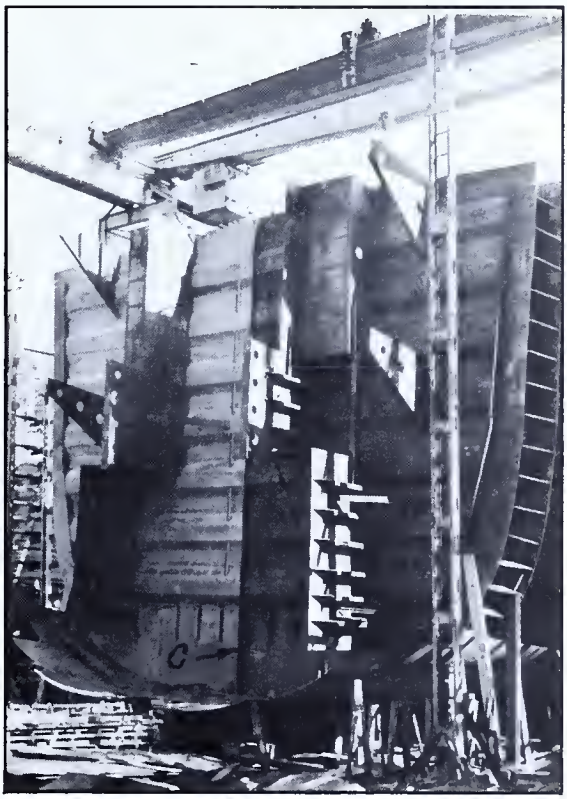


Fig. 145 — *Erecting Transverse Bulkhead (Forward Cofferdam)*

Tools and Materials

1. Bars
2. Maul
3. Wrenches
4. Bucket of ¾" bolts and washers

Equipment

Pennants
Crane

Additional Mechanics Needed: Shipwright and welder.

Procedure

1. Identify and locate the sections to be erected.

Sections will be marked with hull number, transverse bulkhead number, and port or starboard marking. The fore and aft location of the bulkhead is determined from the frame lines.

2. Shackle pennants to lifting pads on top of bulkhead 72, port section (1), Fig. 146.

   Half of the 72 bulkhead is erected first. Owing to the shape of the bilge and since the center line is the deepest part of the bulkhead, it is necessary to lengthen the pennant used on the outboard edge; otherwise, the bulkhead would not hang in a vertical position.

3. Signal crane to take bulkhead to point of erection.

4. Lower bulkhead into position.

   In that the "A", "B" and "C" strakes of shell plating previously have been erected, little difficulty is encountered in swinging this bulkhead into position. See Fig. 145.

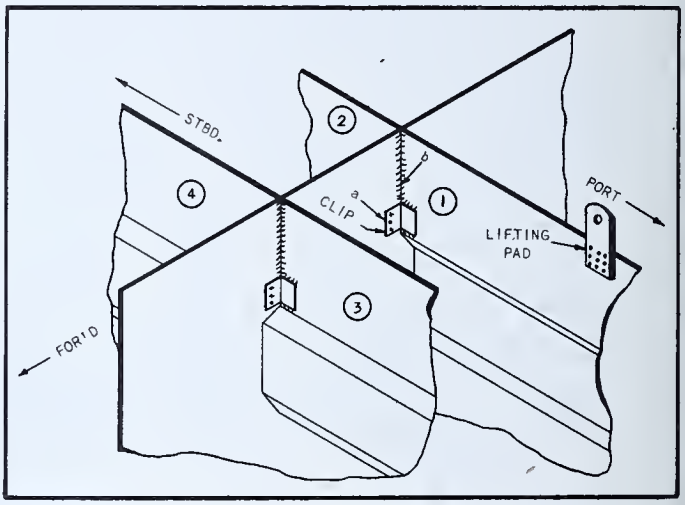


FIG. 146 — *Cofferdam Section*

5. Bolt three hole angle clip "a", Fig. 146, at top of bulkhead to center line bulkhead.

6. Weld transverse bulkhead to center line bulkhead, at "b", Fig. 146. Be sure that this portion of bulkhead is on the set marks before it is welded.

   It is necessary to weld this piece so that the bolts in angle clip "a", may be removed, and that the bolt holes may be used for erecting the starboard transverse bulkhead, (2), Fig. 146.

7. Insert drift pin in bottom angle clip "c", Fig. 145.

   The drift pin is used to keep the bottom of the bulkhead in approximate alignment until the starboard section (2), Fig. 146 is erected.

8. Shore bulkhead at point directly under "C" strake plate, Fig. 147, to prevent sagging of bulkhead. Shipwrights do this work.

9. Unshackle pennants.

10. Erect 72 starboard transverse bulkhead, (2), Fig. 146.

    Procedure Steps 1 - 9 are followed in erecting this section.
    Exception: Step "6", welding of top of bulkhead is omitted. This part remains supported by bolts.

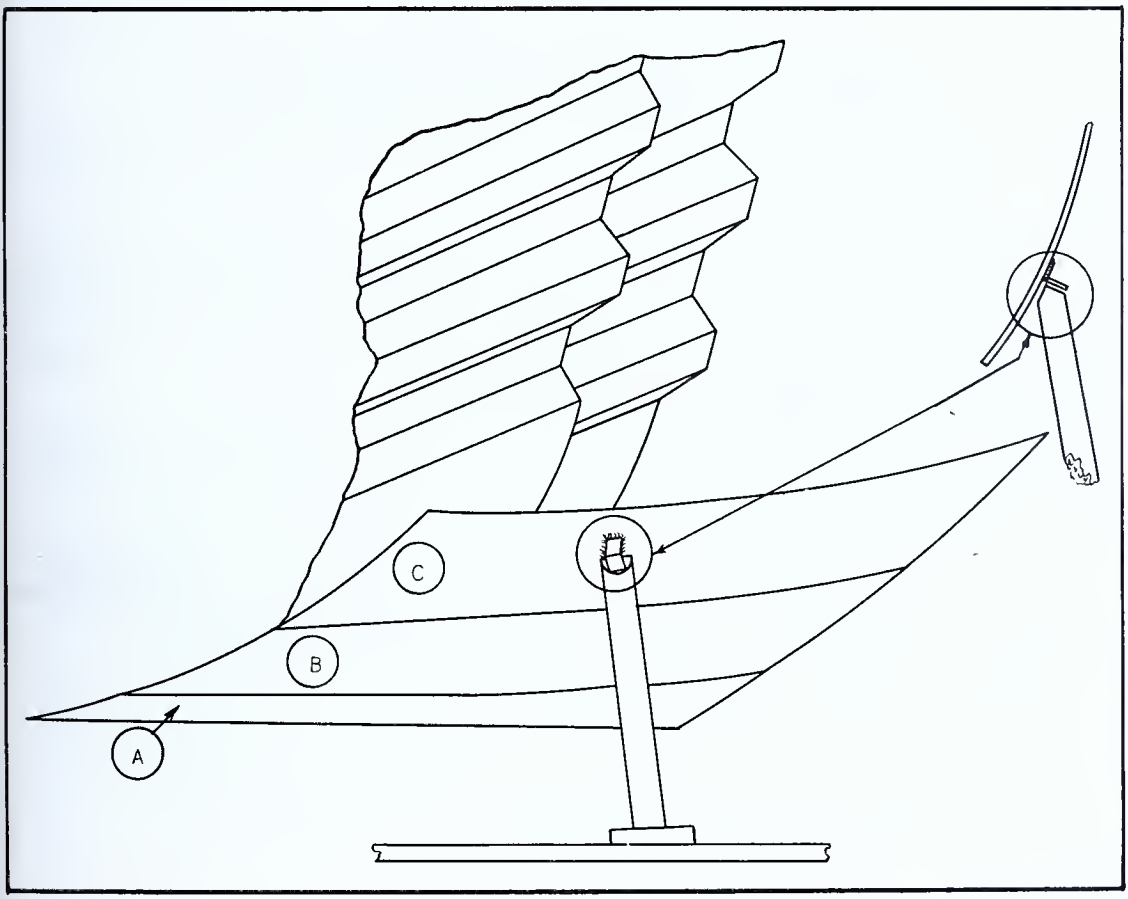


FIG. 147 — *Shoring of "C" Plate to Support Cofferdam*

11. Erect 73 port transverse bulkhead, (3), Fig. 146.

Procedures 1 - 9 are followed without variation in erecting this section.

12. Erect 73 starboard transverse bulkhead, (4), Fig. 146.

Procedures indicated in step "10" are followed without variation in erecting this section.

QUESTIONS

1. **Where are cofferdams located?**
2. **What bulkhead numbers form the forward cofferdam?**
3. **Why will the bulkhead hang out of plumb if pennants of equal length are used?**
4. **What procedure would be used in lifting this bulkhead to an upright position for erection?**
5. **Why is the bulkhead shored on the outboard edge before unhooking the crane?**

JOB SHEET NO. 25
ERECTING FORWARD PUMP ROOM BOTTOM

General Information

The bottom of the forward pump room is incorporated with the floors under the bottom, and is built into a double bottom section. This section extends from bulkhead 73 to bulkhead 77, and when erected forms the frame work under the pump room as well as the pump room bottom.

This is a section similar in appearance, but much smaller than the double bottom shown in Fig. 112.

Tools and Materials

1. Bars
2. Maul
3. Wrenches
4. Bucket of 7/8" and 3/4" bolts and washers
5. Ratchet and clips

Equipment

Four hook pennants
Crane

Additional Mechanic Needed: Welder.

Procedure

1. Identify and locate forward pump room bottom.

   This section is marked: Hull No.....
   Pump Room Bottom.
   73 - 77 (Frame Nos.)

   The frame numbers indicate the point of erection.

2. Attach four hook pennants to lifting pads, as shown in Fig. 112.
3. Signal crane to take section to point of erection.
4. Position section for erection.
   a. Lower pump room bottom section on shell plating "AB", Fig. 148. Retain tension on pennants, so that less difficulty will be encountered in moving section into final position.

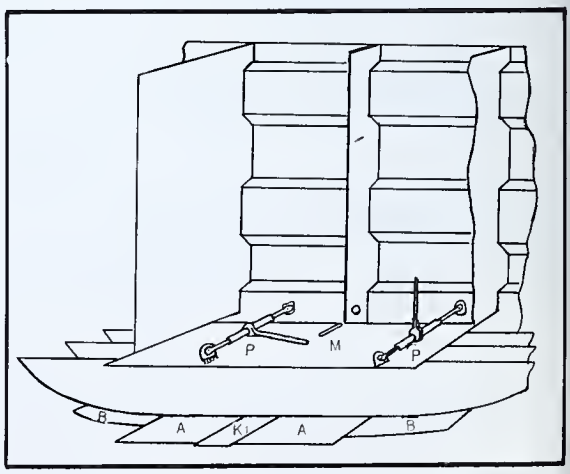


Fig. 148 — *Pulling Bottom Assembly Into Position With Ratchets*

b. Place slot, M, on projection of center line bulkhead, "O".

c. Attach pads and ratchets "P", in positions shown in Fig. 148.

d. Pull ratchets simultaneously until bottom section is against bulkhead "73".

5. Unhook pennants.

Regulators will remove ratchets.

QUESTIONS

1. **What other assembly is similar in appearance to the pump room bottom?**
2. **Why are guide dogs not used in placing this assembly on center line?**
3. **Why are two ratchets used?**
4. **What would happen if the two ratchets were not drawn up uniformly?**

JOB SHEET NO. 26
ERECTING FORWARD FLOORS AND INTERCOSTALS 78 TO 89

General Information

The forward floors are the frame work in the bottom of the forward fuel oil tank. In this section the framing is transverse, with frames about thirty inches apart. Each floor extends from the center line bulkhead outboard. The floors are made from plates cut to the required shape, with a five inch flange at the top. Between each floor is an intercostal. These intercostals are the spacers between frames; when welded they form a built-up girder. The floors and intercostals are of all-weld construction, with the exception that, on some ships, each floor has a bracket with three holes for erection. See Fig. 149.

Fig. 149—*Forward Floors and Intercostals*

Tools and Materials

1. Bars
2. Erectors wrenches
3. Bucket of ¾″ bolts, nuts and washers

Equipment

One ¾″ wire rope pennant
One shackle
One shackle bolt

Additional Mechanic Needed: Welder.

Procedure

1. Identify and locate floors.

   Floors are marked with hull number, drawing number, frame number and port or starboard. Forward floors are numbered consecutively from 77 to 89 inclusive, there being a port and a starboard piece for each number.

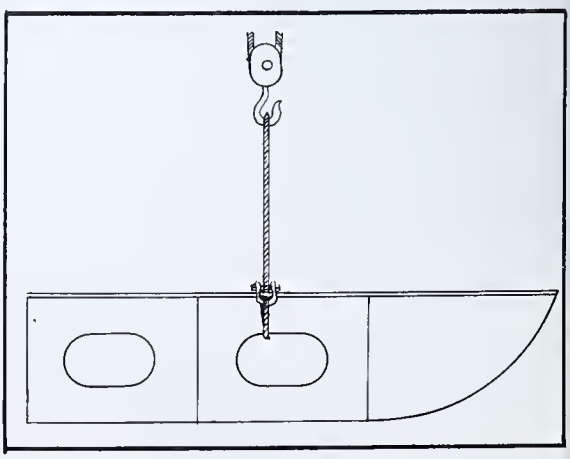


Fig. 150 — *Hook Up for Floors*

Each floor piece matches the corresponding frame set marks on the bottom plating.

2. Shackle a single pennant to the floor, as shown in Fig. 150.

3. Signal crane to take floor to place of erection.

4. Lower floor into position.

   The lowest floor should be placed first, that is, 77, then 78, 79, etc.

5. Position floor for erection.

   Position floor on frame set marks for the corresponding frame number.

6. Install guide clips on both sides of floor, as shown in Fig. 151. This work is done by a welder.

   If time permits, guide clips may be attached prior to erecting floors.

   Note: On ships having brackets on the center line bulkhead, floors will be bolted directly to the brackets.

7. Unshackle pennant.

8. Erect intercostal, "p", Fig. 151 between floors as erection progresses.

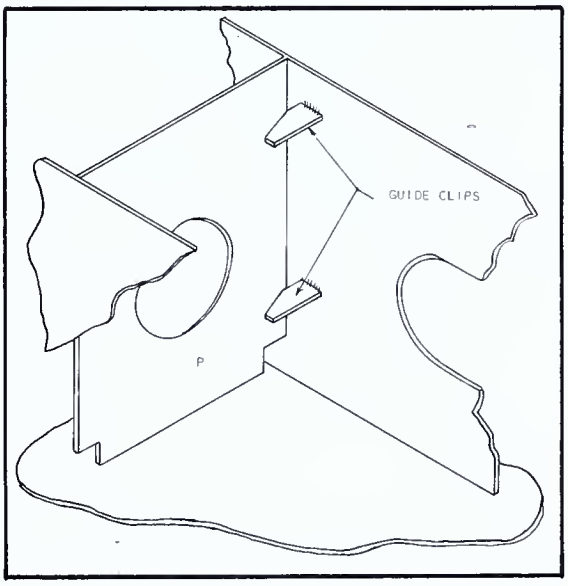


FIG. 151 — *Intercostal Installation*

QUESTIONS

1. **Why must floors be erected in specified locations?**
2. **What are intercostals?**
3. **What are floors?**
4. **What markings identify floors?**
5. **What are the commonly-used floor spacings?**
6. **How many pennants are used in handling floors?**
7. **How are floors fastened into place?**

JOB SHEET NO. 27
ERECTION OF AMMUNITION CHAMBER

General Information

The ammunition chamber is erected on an ammunition flat, which is similar to a deck section. The after end of the chamber is formed by No. 89 bulkhead; the forward end is the No. 97 bulkhead. A longitudinal center line bulkhead divides this chamber into two sections. The sides are formed by two longitudinal bulkheads extending from frame 89 to frame 97. In height the ammunition chamber extends from the ammunition flat, which rests upon web frames, to the second deck. The ammunition chamber, with the exception of the ammunition flat, is erected as one assembly.

The ammunition flat is identified and located by referring to hull number and frame numbers (89 to 97). The built up ammunition chamber will carry the markings "Ammunition Chamber", and "Hull No.....". The ammunition flat rests upon web frames. It is bolted to frame Nos. 93 and 97. Fig 152A.

Tools and Materials

1. Bar
2. Mauls
3. Wrenches
4. Bucket of bolts, nuts and washers
5. Drift pins
6. Guide dogs

Equipment

Wire rope pennants ¾" size
Crane

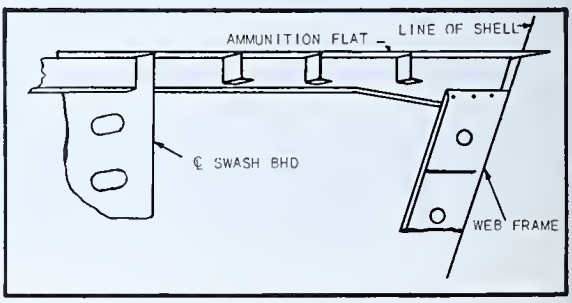


FIG. 152*A* — *Connection of Ammunition Flat to Web Frames*

Erecting Ammunition Flat

PROCEDURE

1. Hook pennants to four lifting pads on ammunition flat. See Fig. 152-B.
2. Signal crane to take piece to position of erection.

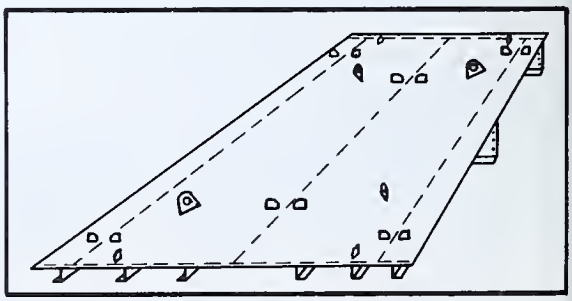


FIG. 152*B* — *Ammunition Flat Showing Guide Dogs and Lifting Pads*

3. Lower flat until it rests on the lower section of the No. 89 bulkhead, and the 93 and 97 web frames.

4. Bolt flange plate stiffeners on underside of flat to web frames 93 and 97, port and starboard. Four bolted connections are necessary.

5. Unhook pennants.

Erecting Ammunition Chamber
(The built-up chamber with the exception of the flat which previously has been erected.)

PROCEDURE

1. Weld guide dogs to set marks on top of ammunition flat. See Fig. 152-B.

2. Hook pennants to lifting pads at top of fore and aft ends of ammunition chamber assembly. See Fig. 153.

3. Signal crane to take assembly to point of erection.

4. Lower assembly onto ammunition flat.

   The lower edges of this assembly must enter guide dogs which have been placed on both sides of set marks on the ammunition flat. These guide dogs hold the assembly on its set marks.

5. Unhook pennants.

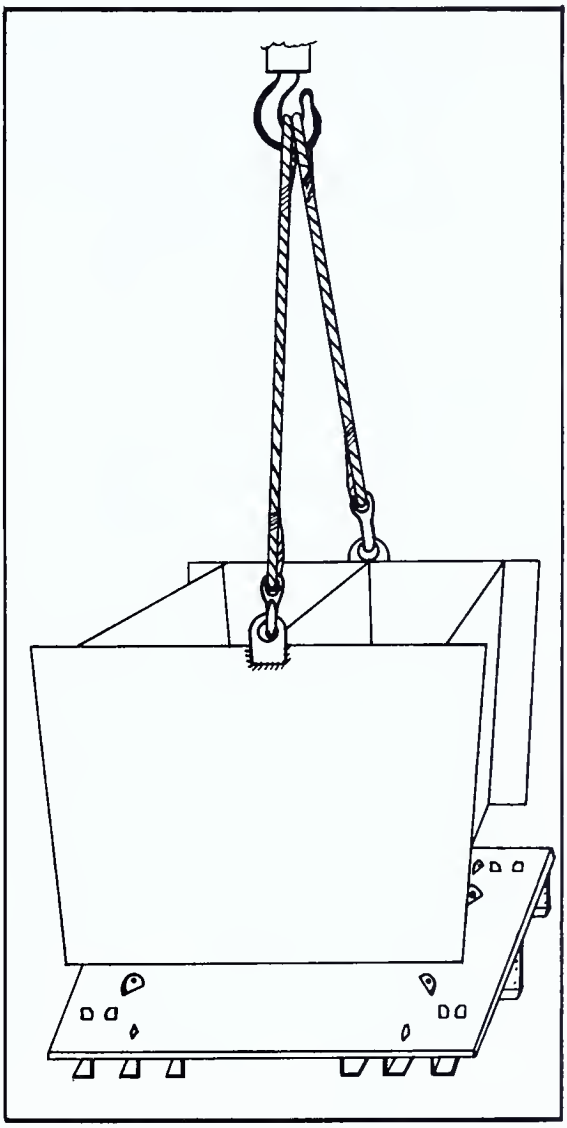


FIG. 153 — *Positioning Ammunition Chamber*

QUESTIONS

1. **What members form the ammunition chamber?**
2. **Where is the ammunition chamber located in the ship?**
3. **Is the ammunition flat handled similar to a deck section?**
4. **What connections are bolted underneath the flat?**

JOB SHEET NO. 28
ERECTING CHAIN LOCKER

General Information

The chain locker usually is built into one large section, divided at the center. It is used for storage of anchor chain. Before erecting, guide clips should be welded to the second deck on the set lines of the chain locker. Fig. 155.

Tools and Materials

None

Equipment

Two heavy wire rope pennants
Large shackles
Capacity for ten tons or more

Additional Mechanic Needed: Welder.

Procedure

1. Identify and locate chain locker.
   In that a tanker has but one chain locker, indication of hull number, forward end and after end are the only identifying marks needed.
2. Shackle pennants to lifting pads.
   Lifting pads are bolted to both top ends of the chain locker.
3. Signal crane to carry assembly to place of erection.
4. Position chain locker for erection.
   Set lines, showing athwartship and fore and aft location of chain locker, are center punched on second deck plating. See Fig. 155. If guide dogs have not been attached by shipfitters, it is necessary that the erector have these welded in place before positioning this assembly.

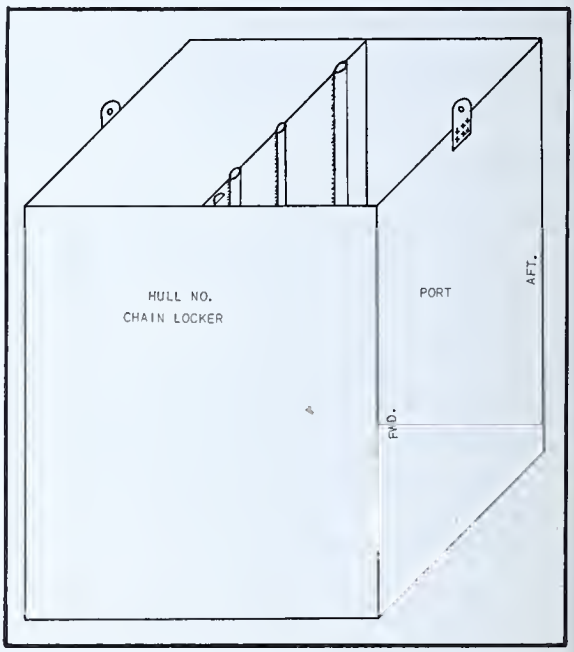


Fig. 154 — *Chain Locker*

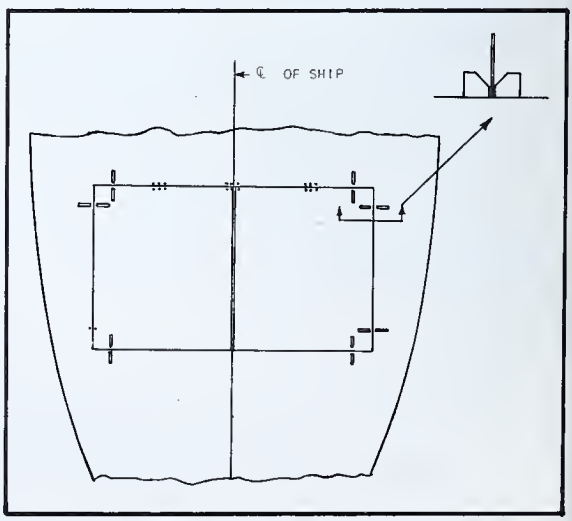


Fig. 155 — *Set Lines and Guide Dogs Used in Positioning Chain Locker*

5. Lower chain locker into position so that the bottom edges enter the guide dogs.

   No additional attachment is necessary.

6. Unshackle pennants.

QUESTIONS

1. **What are set marks?**
2. **On what deck is the chain locker erected?**

JOB SHEET NO. 29
ERECTING BOW ASSEMBLY

General Information

The bow assembly, or stem section, is built in a cradle on the ground. It includes the stem plates, the No. 1 plates of all the strakes, together with the breast hooks, and the forward shell stringers. When assembled the bow section weighs approximately 28 tons.

Tools and Materials

1. Four bars
2. Two mauls
3. Fifteen 7/8″ bolts 8″ long with washers

Equipment

Two heavy pennants
Two heavy shackles
Two shackle bolts
Safe capacity 29 tons
One pennant of 1¼″ wire rope
Two ratchets
A 3-ton chain hoist
2 cranes

Additional Mechanics Needed: Shipwrights, welder, burner.

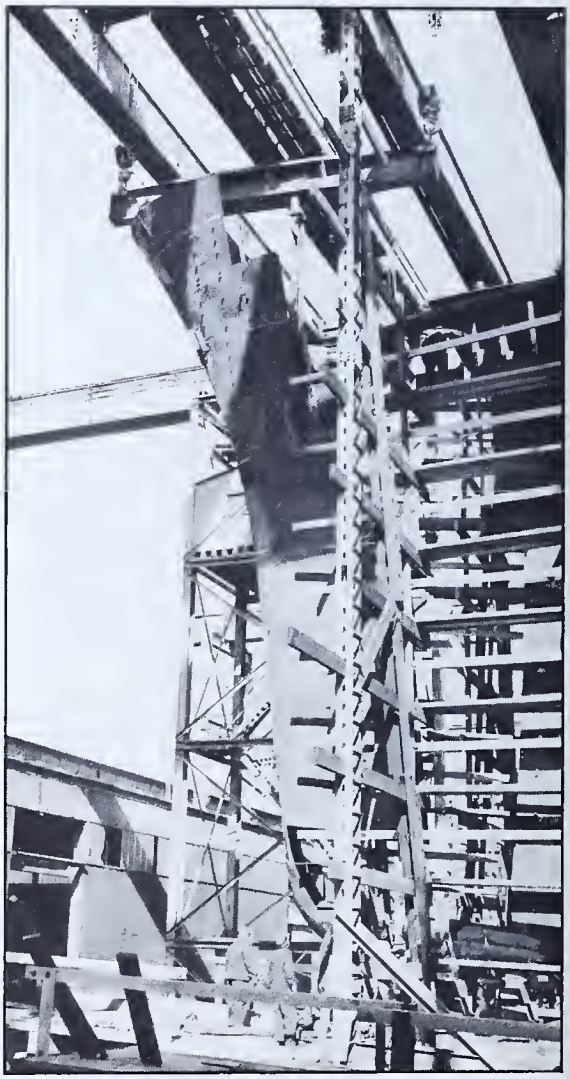


Fig. 156 — *Erecting Bow Assembly*

Procedure

How to Remove Bow Assembly From Cradle

1. Shackle one crane to lifting pads at top of bow assembly. Fig. 157.
2. Shackle a second crane to lifting pad at inside bottom center of bow assembly. Fig. 157.
3. Hoist both cranes, keeping the load on an even keel, until the bow assembly is clear of the cradle.

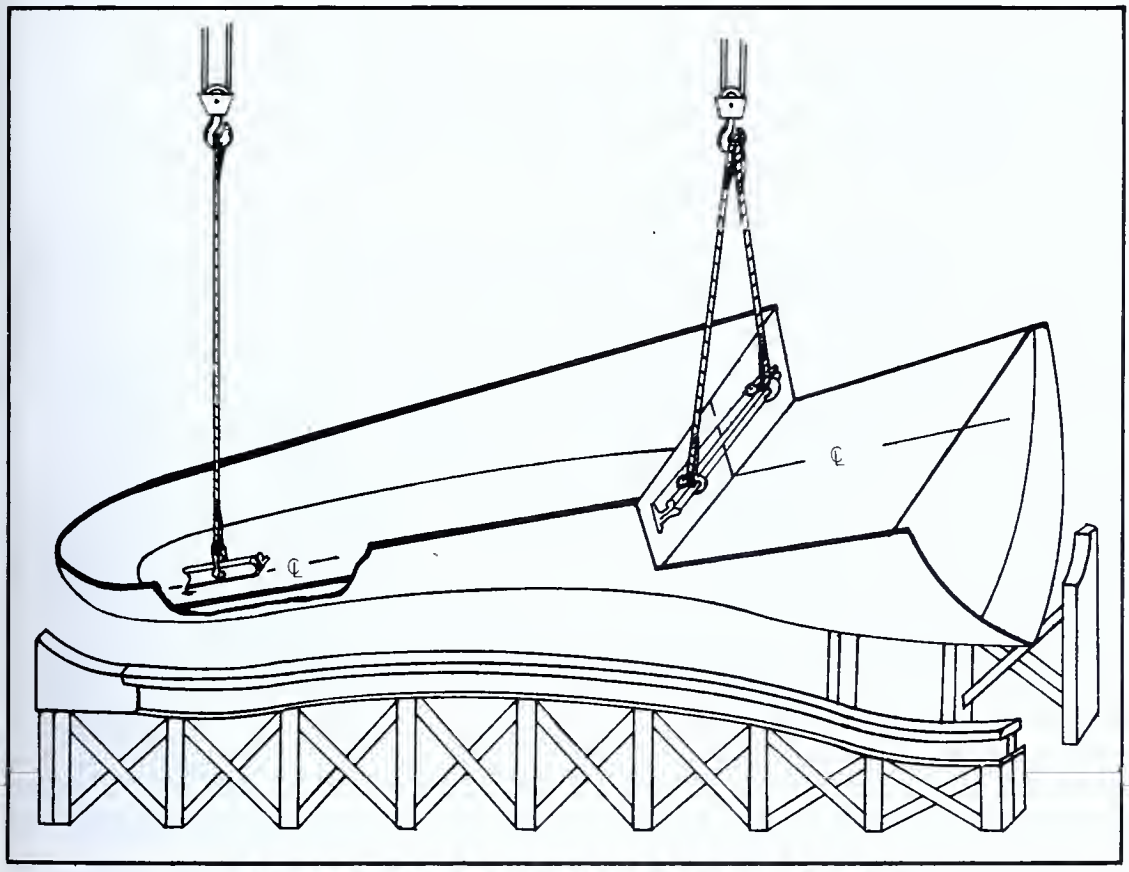


FIG. 157 — *Two Cranes Lifting Bow from Cradle*

4. Lower load in clear space.

Note. If crane hooked to top of bow is of sufficient capacity, erection of the bow may proceed. If, however, it is necessary to use two cranes to lift the bow, the load must be unshackled so that an equalizer may be attached.

Erection of Bow Assembly Using Two Cranes With Equalizers

1. Attach 3-ton chain hoist to center line of ship about 10′ above keel, as shown in Fig. 158.

The hook of the chain hoist is attached to a cable choker "e", Fig 158, which is fastened to a lightening hole by means of a toggle "a". A piece of angle or heavy pipe may be used as a toggle.

2. Couple equalizer to cranes.

An equalizer is a device which distributes the load proportionately between the two cranes.

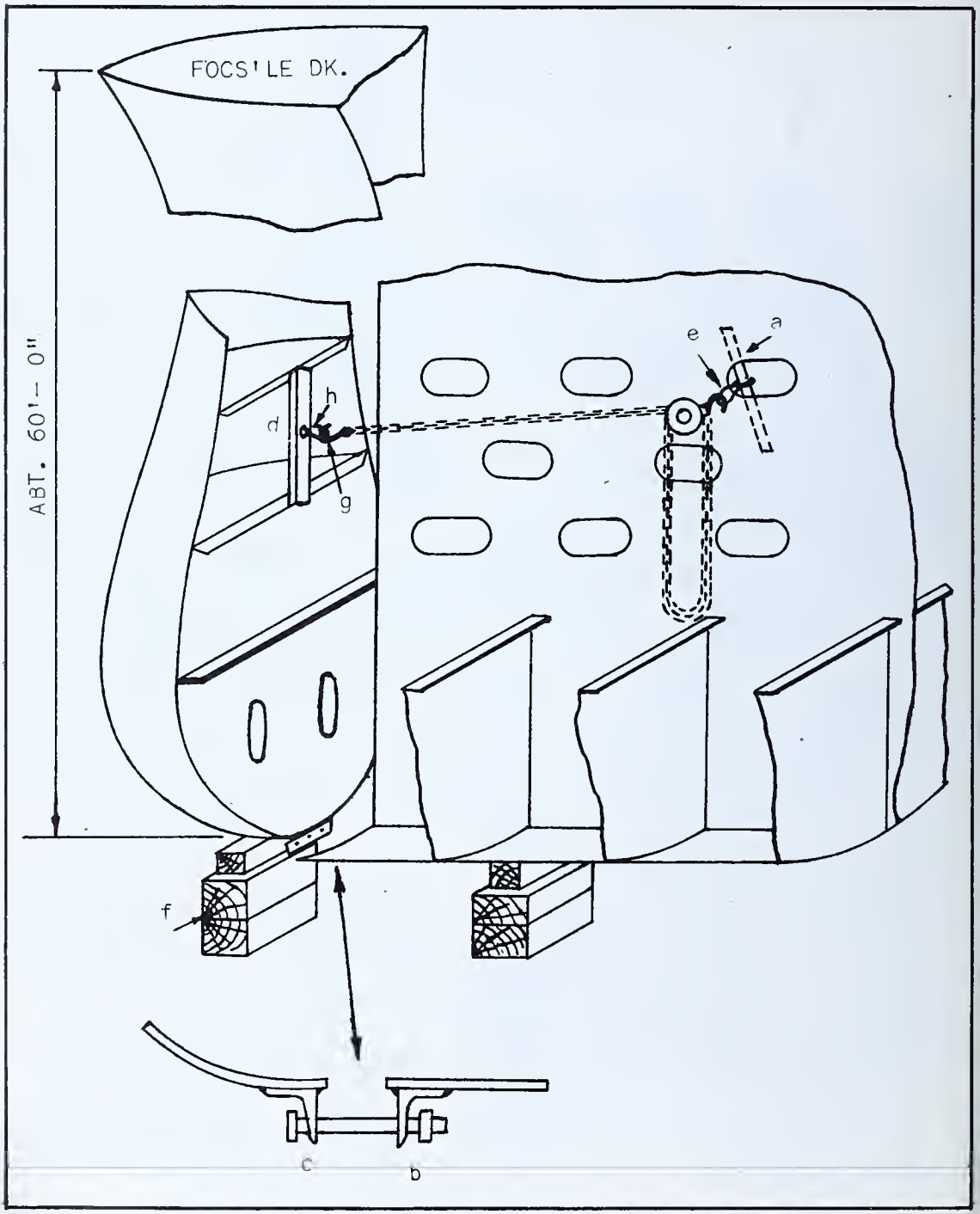


FIG. 158 — *Pulling Bottom of Bow With Chain Hoist*

Note: If a crane having a safe working capacity of thirty tons is available, only one crane will be used, thus eliminating the equalizer.

3. Loop pennants through eye of equalizer and shackle both ends of each pennant to the lifting pads of bow assembly. See Fig. 156.

4. Hoist to vertical position.

   As the bow is being lifted it is necessary that the crane be moved toward the base of the bow assembly, thus keeping the bow from being dragged along the ground.

5. Signal crane to swing bow into position for erection.

6. Attach hook "g", Fig. 158, of chain hoist to shackle "h", which is attached to lifting pad "d" on inside center line of bow assembly.

7. Pull bottom of bow into contact with bottom of hull at the keel plate using the chain hoist.

   It may be necessary to have cranes move forward so that the top of bow assembly will not bind against the upper deck.

8. Set bottom of bow assembly on keel block "f", previously placed by shipwrights for its support.

   The height of the keel block is established so that the bow will align with the bottom keel plate when it rests on the block.

9. Bolt bottom of bow assembly to keel plate by means of angle clips "b" and "c." Three 7/8" bolts, 8" long are required.

10. Bring upper deck connection of bow and upper deck connection of hull together by traveling the cranes aft.

11. Fasten top of bow to hull by placing bolts through connecting angle clips, "a" and "b", Fig. 159.

    Connections on both upper deck and second deck may be made as soon as the top of the bow has been pulled back.

12. Have shipwrights tighten wedges of bow keel blocking.

13. Unshackle and remove equipment.

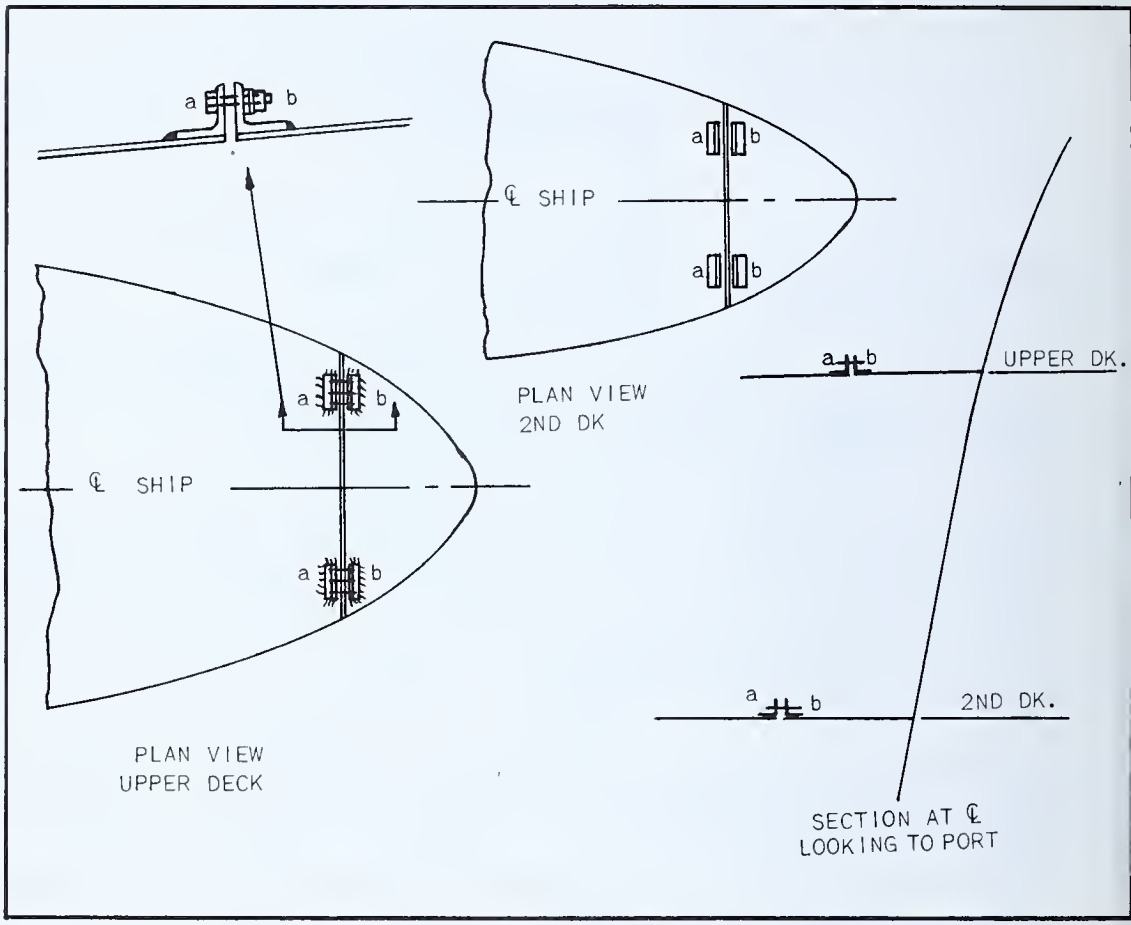


FIG. 159 — *Angle Connections on Second and Upper Decks of Bow and Hull*

QUESTIONS

1. **In what position is the bow assembly constructed?**
2. **Where are lifting pads attached?**
3. **How is the bow assembly lifted into a vertical position?**
4. **When is it necessary to use an equalizer?**
5. **What determines the height of the bow assembly?**
6. **How is the bottom of the bow assembly pulled into contact with the forward bottom edge of the hull?**
7. **Which part of the bow assembly is first bolted to the hull?**
8. **List the connections made in erecting a bow assembly.**
9. **What additional men are needed in erecting the bow assembly?**

JOB SHEET NO. 30
ERECTING HAWSE PIPE

General Information

A hawse pipe is a heavy steel casting through which the anchor chains enter the hull. Two hawse pipes are erected, one on the port side of the bow, and one on the starboard side of the bow. After being hoisted into approximate position by means of a crane, the hawse pipe is positioned by means of chain hoists.

Although hawse pipes formerly were erected in one piece, modern practice favors erection of the hawse pipe in three pieces — the pipe, the bolster and the collar, as shown in Fig. 160.

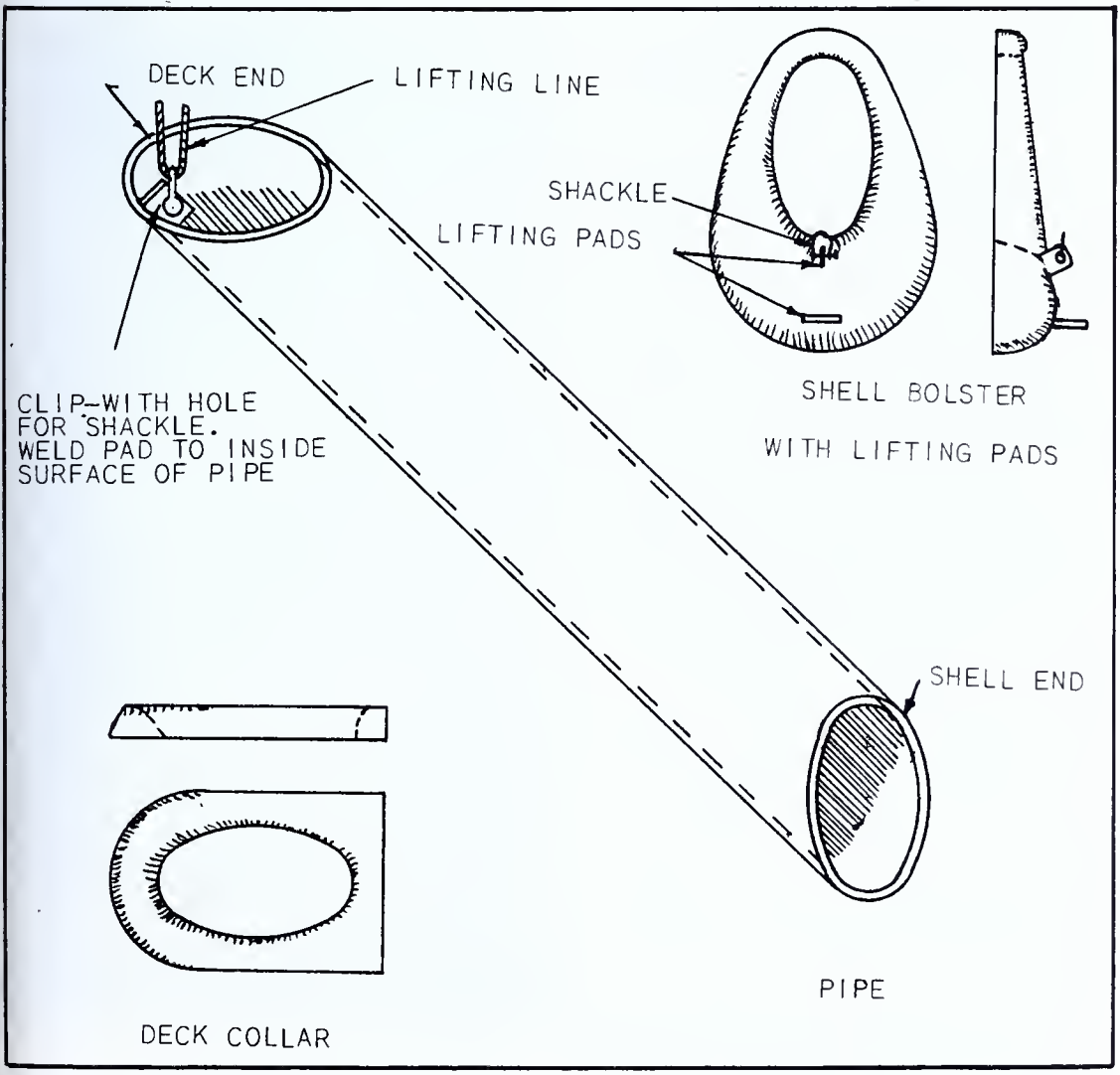


Fig. 160 — *Hawse Pipe Before Assembly*

Tools and Materials	Equipment
None	Wire rope pennants, ¾″ size Crane One 3-ton chain hoist Two 2-ton chain hoists

ADDITIONAL MECHANICS NEEDED: Shipfitter, burner, welder.

PROCEDURE

1. Identify and locate hawse pipe.

   The three pieces of each hawse pipe are marked with hull number, and port and starboard markings.

2. Shackle a single pennant to lifting pad which is welded inside the pipe at the top. See Fig. 160.

3. Partly lower pipe into hole in foc'sle deck.

   Approximately 6′ of the hawse pipe length is lowered through the hole cut in deck. See Fig. 161.

   Owing to the weight of the hawse pipe, it is difficult to swing it into position below deck without the use of chain hoists.

   The hoists are attached in a manner which permits rolling or moving the lower part of the hawse pipe in any desired direction by pulling or releasing one or both hoists.

4. Place "A" frame over hawse pipe location, and attach 3-ton chain hoist to "A" frame.

5. Attach chain hoist hook to hawse pipe lifting pad with a shackle.

6. Take up slack on chain hoist and slack off on crane. Remove crane. See Fig. 162.

FIG. 161 — *Chain Hoist Rigged to Place Lower End of Hawse Pipe*

7. Rig two 2-ton chain hoists under foc'sle deck, as shown in Fig. 161.

8. Adjust position of hawse pipe so that its upper end is flush with the deck, Fig. 163.

9. Turn job over to shipfitter.

   The shipfitter will make any necessary final adjustments in position of pipe, and will supervise the welding of the deck end of pipe, and burning of lower end flush with the side shell. This lower end is welded to the shell after burning.

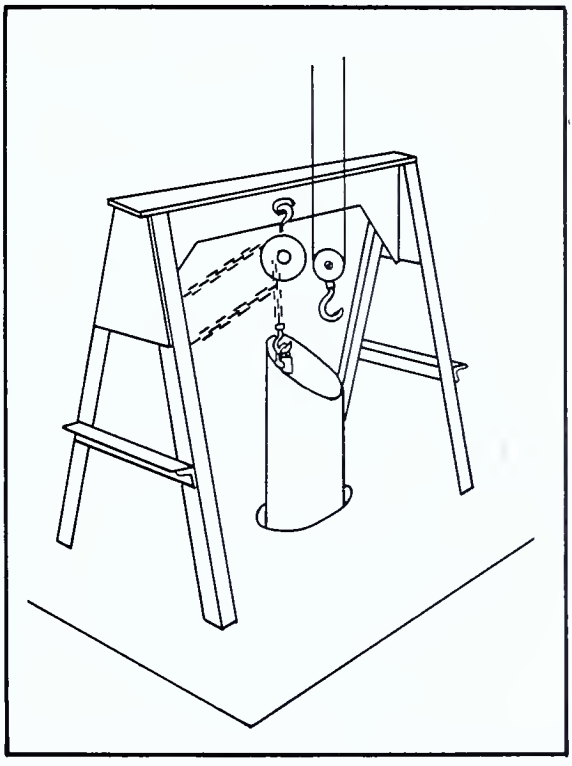


FIG. 162 — *"A" Frame Supporting Hawse Pipe*

10. Place bolster on outer lower end of hawse pipe, when requested by shipfitter.

    a. Shackle pennant to bolster as shown in Fig 164.

    b. Lower bolster to position at mouth of hawse pipe, "a", Fig. 165.

    c. Attach bolster to pennant which has been lowered through hawse pipe. The other end of this pennant is attached to the 3-ton chain hoist on the "A" frame.

    d. Unshackle crane from bolster.

    e. Rig two small chain hoists "b", to lifting pads, "c" on bolster.

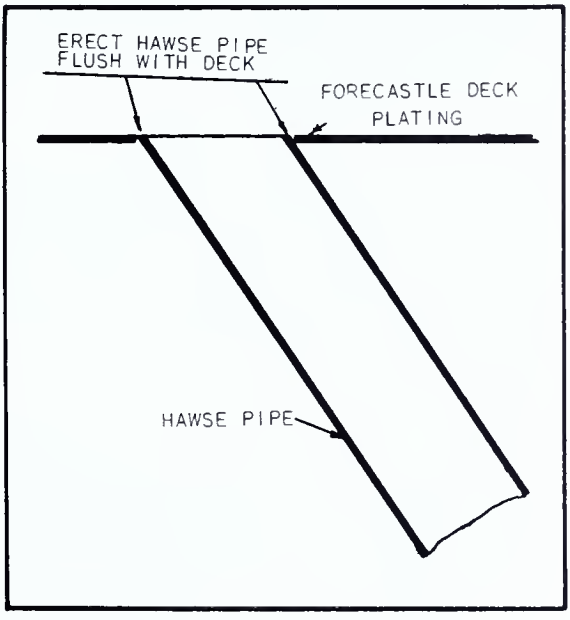


FIG. 163 — *Section Through Center of Hawse Pipe*

f. Pull bolster into position, lifting or lowering any or all hoists as may be necessary, until bolster aligns with set marks which have been placed on the shell plating by the shipfitter.

11. Turn job over to shipfitter for fitting and welding of the bolster.

12. Place collar in position over deck end of hawse pipe, upon notification from shipfitter.

The collar is lifted by shackling a pennant around the rim of the collar. The collar may be moved into final position with a pinch bar.

13. Remove all rigging and return to the rigging loft.

FIG. 164 — *Erecting Bolster*

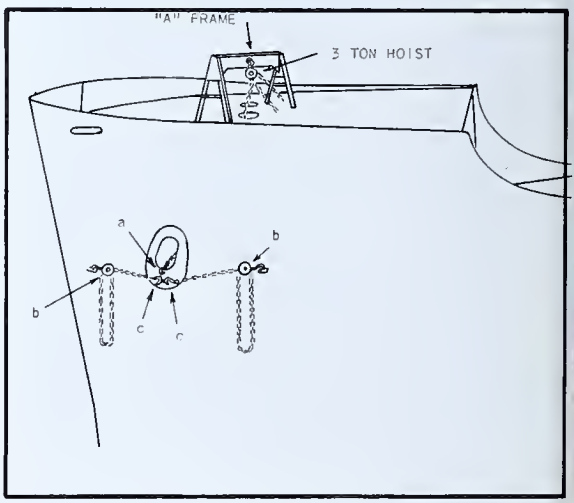


FIG. 165 — *Chain Hoist Used to Place Bolster*

QUESTIONS

1. **Where are hawse pipes located?**
2. **List the three pieces which are assembled to make a complete hawse pipe.**
3. **Why are three chain hoists used in setting a hawse pipe?**
4. **What is an A frame?**

Part IX

ERECTING RIVETED CARGO AND TANKER VESSELS

In comparison with all-weld vessels, there are minor differences in erecting riveted hull assemblies. Those erection jobs which typify procedures in erecting riveted vessels are presented in this part.

The sequence of erection of hull assemblies of riveted vessels differs but slightly from the sequence of erection of all-weld ships. The principal distinction between erection of the two types of vessels is that in erecting all-weld assemblies butt connections are used, whereas in riveted construction there are laps, either of plates or of angles.

Typical Riveted Connections

A combination of both welding and riveting is being employed in the construction of many vessels.

Work Assignments in the erection of riveted cargo vessels are as follows:

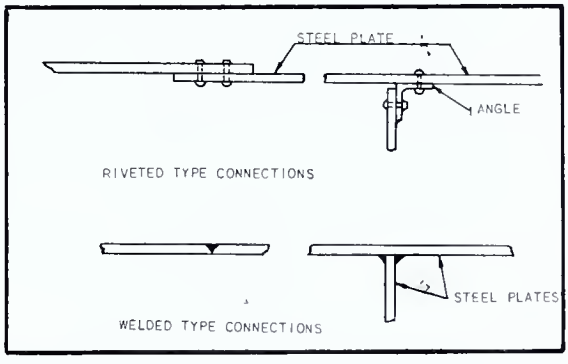


FIG. 166—*Welded and Riveted Connections*

JOB No.	TITLE
31.	Erecting Riveted Bottom Shell Keel Plate.
32.	Erecting Riveted Bottom Shell Plates.
33.	Alternate Weld Method of Erecting Cargo Bottom Shell Plating.
34.	Erecting Double Bottom Sections.
35.	Erecting "E" Plates and Shell Framing.
36.	Erecting Bulkheads.
37.	Erecting Deck Beams and Longitudinal Girders.
38.	Erecting Shell Plates — "In and Out" Method.
39.	Erecting Shell Plates — Progressive Method.
40.	Erecting Shell Plating by Starting at Top and Working Down.
41.	Shell Liner Installation.

JOB SHEET NO. 31
ERECTING RIVETED BOTTOM SHELL KEEL PLATE

General Information

The bottom shell plates of riveted construction are erected individually. See Fig. 167.

Tools and Materials

1. Two bars
2. One maul
3. Spud wrench
4. Bucket of ¾″ bolts, 3″ long, with washers
5. Drift pins

Equipment

Two ¾″ wire rope pennants 18′ long
Two shackles
Two ¾″ shackle bolts

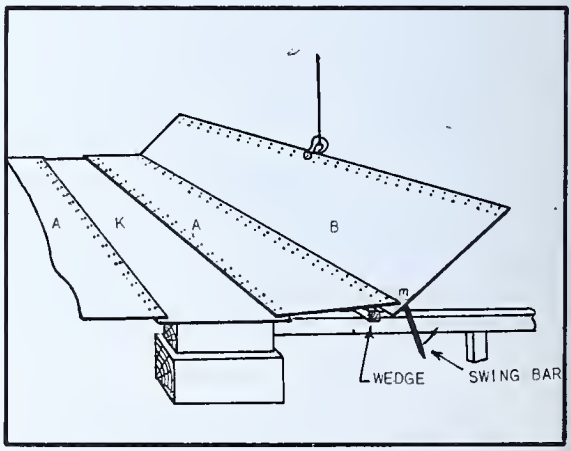


Fig. 167 — *Lapping "B" Plate Under "A" Plate*

Procedure

(*General procedures as outlined in Job Sheet No.* 1 *are followed in erecting this and succeeding jobs.*)

1. Shackle pennants to the plate and remove from rack.

   Shackle bolts are inserted in rivet holes near the center of the plate so that the after end is low, thus providing for the declivity of the shipway.

2. Signal crane operator to take the plate to the point of erection.

3. Have the plate laid upside down.

   The plate is upside down when the countersunk portions of the holes are on the side turned upward.

4. Have shipwrights strike the center line on the inverted plate.

5. Turn the plate right side up.

6. Hoist plate to slightly clear the keel blocks.

7. Lower the plate into position.

As the erectors steady the plate it can be moved over the blocks and lowered into position. In lowering the plate it is necessary that the center line on the plate match the center lines on the blocks.

The first plate must be set on the mark established for the midship setting of the plate. The ends of succeeding plates are to be lapped, if the type of construction calls for lap butts; otherwise, the ends will be butted together and either fastened by welding or by a butt strap, as indicated by plate markings.

8. Bolt the plate in position.

The first plate is shored; succeeding plates are bolted at the end to the previously-erected plate.

QUESTIONS

1. **Which keel plate is the first to be laid?**
2. **Why must the center line on the keel plate match the center line on the blocks?**
3. **Why is the plate hooked with the after end low?**

JOB SHEET NO. 32
ERECTING RIVETED BOTTOM SHELL PLATES

General Information

Riveted shell plating usually has lapped seams. The "A" plate laps on the top of the keel plate, and on the top of the "B" plate. The "C" plate laps on the outboard edge of the "B" plate. See Fig. 167.

Tools and Materials	Equipment
1. Two bars	Two ¾" wire rope pennants 18' long
2. One maul	Two shackles
3. Spud wrench	Two shackle bolts, ¾"
4. Bucket of ¾" bolts, 3" long, with washers	

Procedure

1. Identify and locate the plate to be erected. (Refer to Job Sheet No. 1, step "1".)
2. Shackle the pennants to the outboard edge of the "A" plate. permitting the inboard edge to hang down.
3. Signal the crane to take the plate to the point of erection.
4. Lower the plate into position.

   The "A" plate is positioned so that the proper rivet holes match. The plate is landed about 6" inboard from the edge of the keel plate, and then tipped outward so that the plate will lower in a horizontal position. See Fig. 167.

   The correct hole at each end of the plate is spudded into position while lowering the plate.

5. Bolt the "A" plate into position by inserting bolts through the seam holes.
6. Raise the outboard edge of the "A" plate about 3" off the cribbing timbers. See Fig. 167.
7. Slip a wedge under the raised edge of the "A" plate. (See Fig. 167.)

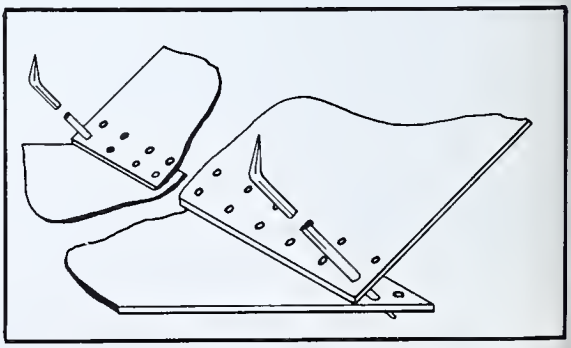


Fig. 168 — *Spudding Holes*

The wedge holds the "A" plate in position so that the "B" plate may be slipped under it.

8. Shackle pennants to the outboard edge of the "B" plate, permitting the inboard edge to hang down.
9. Signal the crane to take the plate to the point of erection.
10. Lower the "B" plate into position with the inboard edge landing on the cribbing near the raised edge of "A" plate.
11. Tip the "B" plate outward and work the inboard edge under the "A" plate by using the bars as a pry, as shown at "m". Fig. 167.
12. Remove the wooden wedges.
13. Bolt the "A" and "B" plates together.
14. Erect "C" plates.

In erecting the "C" plates the procedure outlined for erecting the "A" plates is followed.

(*The above operations are continued until the bottom shell plating has been erected.*)

QUESTIONS

1. **Why must the "A" plate be landed about 6″ inboard on the keel?**
2. **How would you find the correct hole to spud with the bar?**
3. **Why is the outboard edge of the "A" plate wedged up?**
4. **What form of plating is used here?**
5. **Where will you place the bolts to secure these plates? How many bolts are needed?**

JOB SHEET NO. 33
ALTERNATE WELD METHOD OF ERECTING CARGO BOTTOM SHELL PLATING

General Information

The keel plate and the "A," "B," "C" plates are welded into one unit for one type of all-weld shell plating. These sections are equipped with four lifting pads for handling and erecting. When the keel is laid with these sections, one side of "A," "B," "C" strakes is also laid. See Fig. 169.

Tools and Supplies

1. Two bars
2. One maul
3. Spud wrench
4. Bucket of ¾" bolts 3" long, with washers

Equipment

Four ¾" hook pennants 18' long

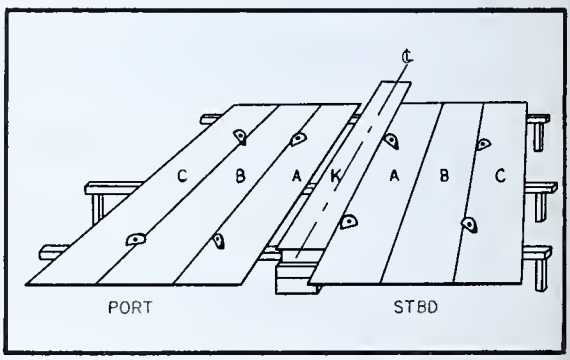


Fig. 169 — *All Weld Cargo Bottom Shell Plating*

Procedure

1. Hook the four pennants into the lifting pads of the keel plate assembly.
2. Signal the crane to take the plate to the point of erection.
3. Lower plate assembly into place, being careful that the center line on the keel plate matches the center line on the keel blocks. Start at the established midship mark.
4. Unhook the pennants.
5. Have the crane pick up the remaining "A," "B," "C" plate section and take it to the point of erection.
6. Lower this section onto the cribbing so that the proper frame lines match those on the keel.

   The plates are placed edge to edge, since welded sections do not lap over one another.

QUESTIONS

1. How many plates are in each assembly?
2. What plates make up each assembly?
3. Why must the center line on the plate be matched with the center line on the blocks?
4. What hoisting equipment is used in this erection job?
5. Why are the seams not lapped?
6. How are the sections fastened?
7. How would declivity affect the work procedure as stated in this job?

JOB SHEET NO. 34
ERECTING DOUBLE BOTTOM SECTIONS

General Information

The double bottom on a cargo ship extends from the forepeak bulkhead to the afterpeak bulkhead. The space between the shell plating and the tank top plating is used for fresh water and fuel oil storage. These sections are handled in a similar manner to those on tankers, except that the first section is the midship section. From midship, the sections are worked both forward and aft until the completed double bottom has been erected.

The procedures used in erecting double bottom sections on cargo ships are similar to those employed in erecting the double bottom sections which are located under the engine room of a tanker. However, in cargo ship erection, the midship double bottom section is first erected.

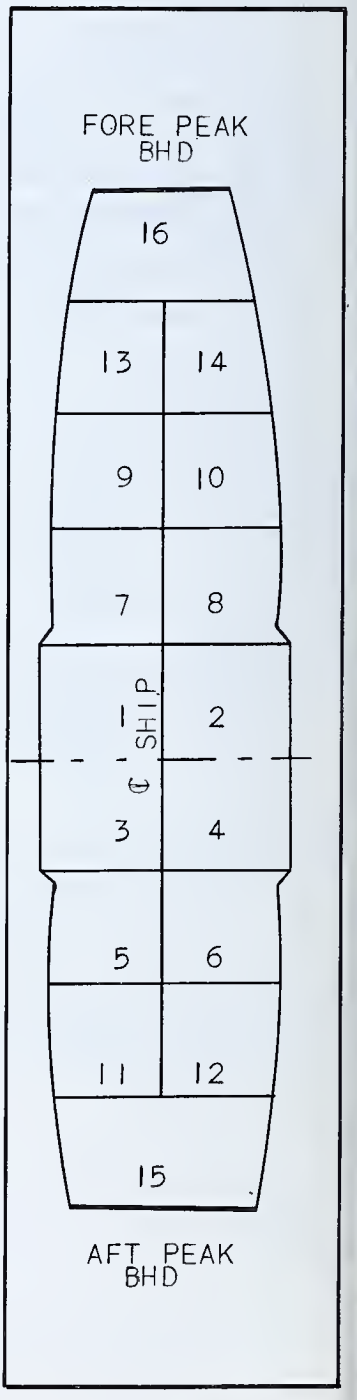


Fig. 170 — *Sequence in Erecting Double Bottom Section*

Procedure

1. Erect midship port double bottom section "1." (Fig. 170.)
2. Erect midship starboard section "2." (Fig. 170.)
3. Erect port section "3."
4. Erect starboard section "4."
5. Erect port section "5."
6. Erect starboard section "6."
7. Erect port section "7."
8. Erect starboard section "8."
9. Erect port section "9."
10. Erect starboard section "10."

11. Erect port section "11."
12. Erect starboard section "12."
13. Erect port section "13."
14. Erect starboard section "14."
15. Erect section "15."
16. Erect section "16."

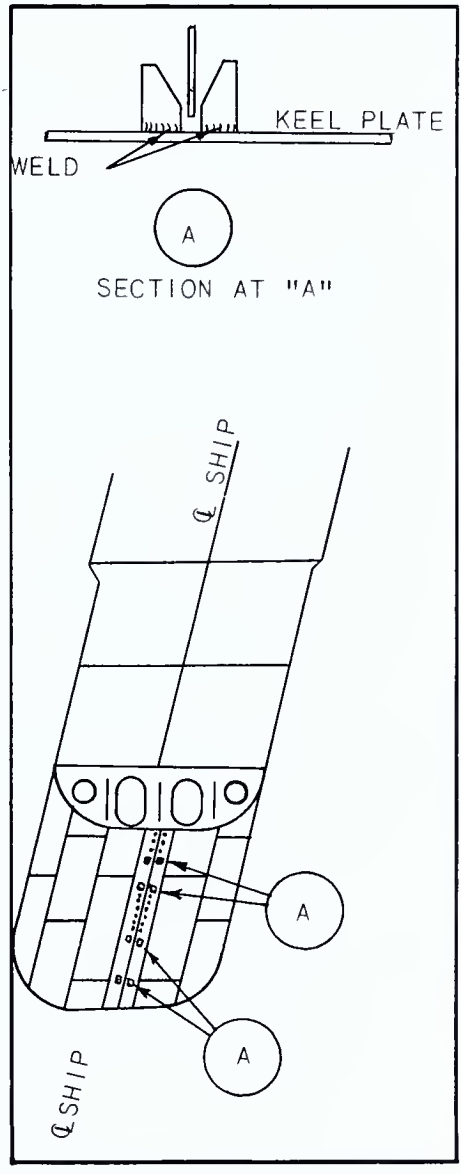


FIG. 171 - *A — Typical Detail of Floor Section Set Lines and Frame*

Positioning Port Sections

All port double bottom sections are assembled with the center line vertical keel. These port sections are positioned by means of guide dogs, detail "A", Fig. 171 - A. After properly locating the first section, succeeding sections are positioned by placing them against the previously - erected section.

Positioning Starboard Sections

Each starboard double bottom section is positioned against its corresponding port section. Tank top plate "b", Fig. 171-B, projects beyond the last floor "c", Fig. 171-B, on the after transverse ends of double bottom sections 3, 5, 11. Forward of port section "1", this projection is on the forward transverse ends of plates 7, 9, and 13.

The above conditions also apply to all port sections.

In erecting double bottom sections the intercostal "a", Fig. 171-B, must be forced under the tank top plate "b". Ratchets are often necessary to pull these sections together.

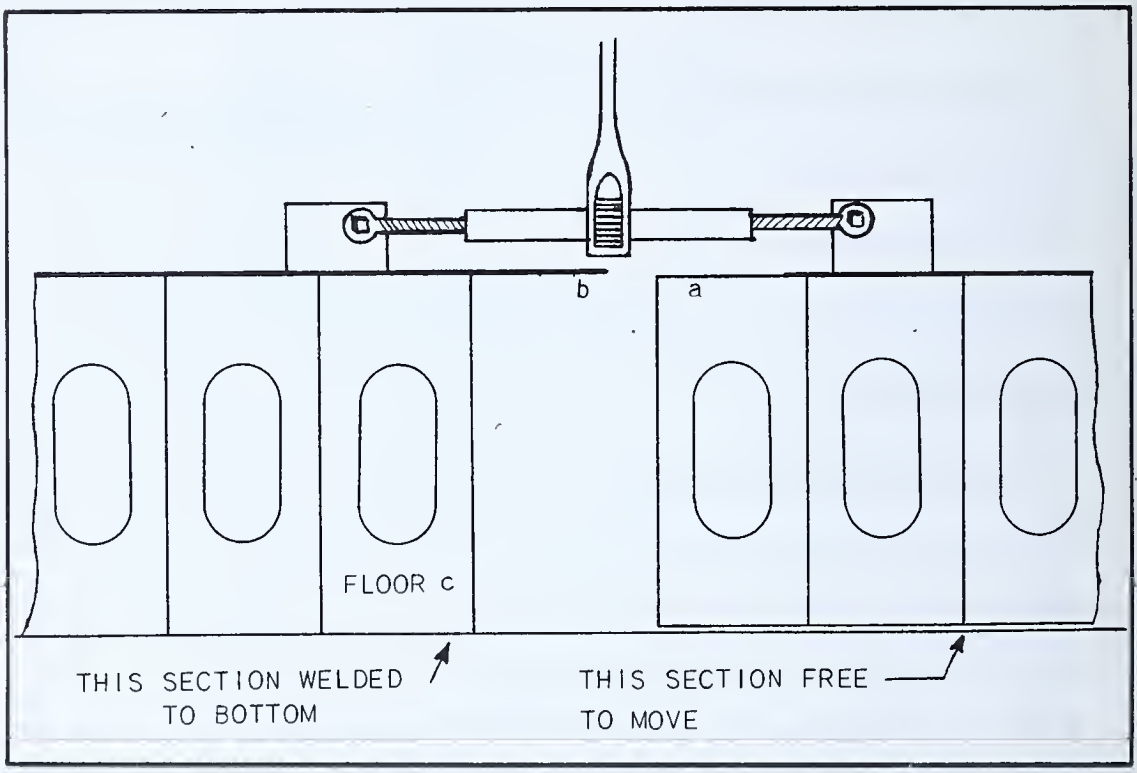


FIG. 171 - *B — Pulling Transverse Ends of Double Bottom Section Together*

QUESTIONS

1. **Why do the double bottom sections extend from the forepeak bulkhead to the afterpeak bulkhead on cargo ships?**
2. **Why is the midship section erected first?**
3. **How are two adjoining sections pulled together when they bind?**
4. **How are the larger sections handled when their weight is beyond the capacity of the crane?**
5. **What use is made of the double bottom space?**

JOB SHEET NO. 35
ERECTING "E" PLATES AND SHELL FRAMING

General Information

The "E" strake of shell plates is erected along the margin plate at the tank top before the framing is started. This simplifies the erection of the "E" plate and also makes it possible to bolt the frames to the "E" plate so that they may be held in position. In that the "E" plates support shell framing, and vice versa, the erection of these members is considered as one job.

Tools and Materials

1. Bars
2. Maul
3. Wrenches
4. Drift pins
5. Bolts, nuts, washers

Equipment

Two ¾" wire rope pennants
Two shackles
Two ¾" shackle bolts

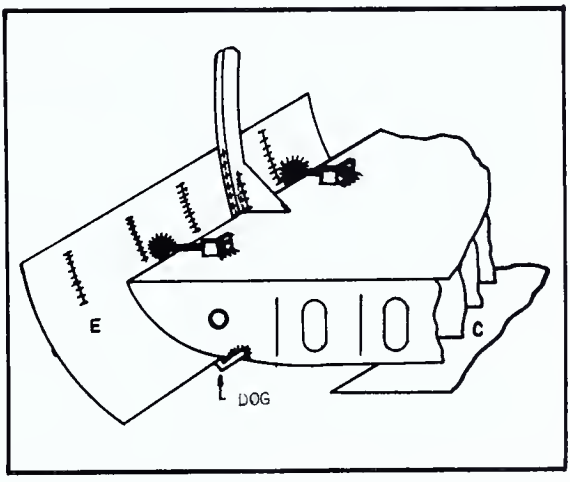


FIG. 172 — *"E" Strake Plates Erected Along Margin Plate at Tank Top*

ADDITIONAL MECHANIC NEEDED: Welder.

Procedure

1. Identify and locate members to be erected.
2. Shackle pennants to "E" plate.
   These plates are handled so that the top edge of the plate hangs in conformity with the declivity of the shipway.
3. Signal crane to take plate to the point of erection.
4. Position plate for erection.
5. Have the clip angles welded to the tank top and a dog welded to the floor plating. See Fig. 172.

6. Secure plate in position by means of clip angles, bolts, and dogs. Fig. 172.

7. Unshackle pennants.

Erecting Transverse Shell Frames

PROCEDURE

1. Identify and locate frame to be erected.

   The frame erection should start amidships and proceed forward and aft.

2. Shackle pennant to rivet hole in top end of frame.

3. Signal crane to take frame to point of erection.

4. Position frame for erection.

   The exact position of frame is determined by frame number, port or starboard markings, and by matching rivet holes in shell plating.

5. Secure bottom of frame in position.

   The bottom of the frame is bolted to the bracket which has been assembled to the bottom shell section.

6. Insert two bolts through shell frame and "E" plate connections and tighten.

7. Bolt the frame to the spacer ribband. See Fig. 173.

8. Unshackle pennant.

   Note: At hatch ends the shell frames will be of web frame construction. These will be set to frame set lines and buttock marks and welded to the tank top plating.

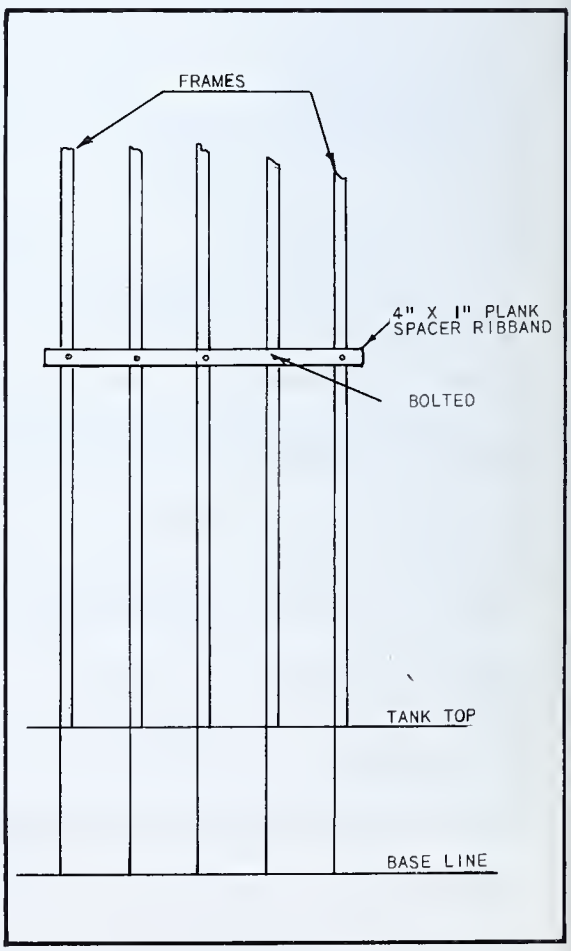


FIG. 173 — *Ribbands Attached to Hold Shell Frames in Position*

QUESTIONS

1. Why are the "E" plates erected at this time?
2. Why are "E" plates not bolted to the tank top?
3. Would you hook this plate to the crane with after or forward end heavy?
4. How many temporary fastenings should be used to safely fasten the plate?
5. Why is a temporary ribband fastened to the shell frames?
6. How do you reach the top of an erected frame to unhook the crane?

JOB SHEET NO. 36
ERECTING BULKHEADS

General Information

Transverse bulkheads on cargo ships differ materially from those erected on tankers. In cargo ships the bulkheads extend from the tank top plating up to the third deck level, a height of about eighteen feet. Transverse bulkheads are divided at the center line of a ship, each port and starboard section being erected individually.

These bulkheads are of flat plate construction, with flanged plate stiffeners spaced approximately every thirty inches vertically. In that these bulkheads

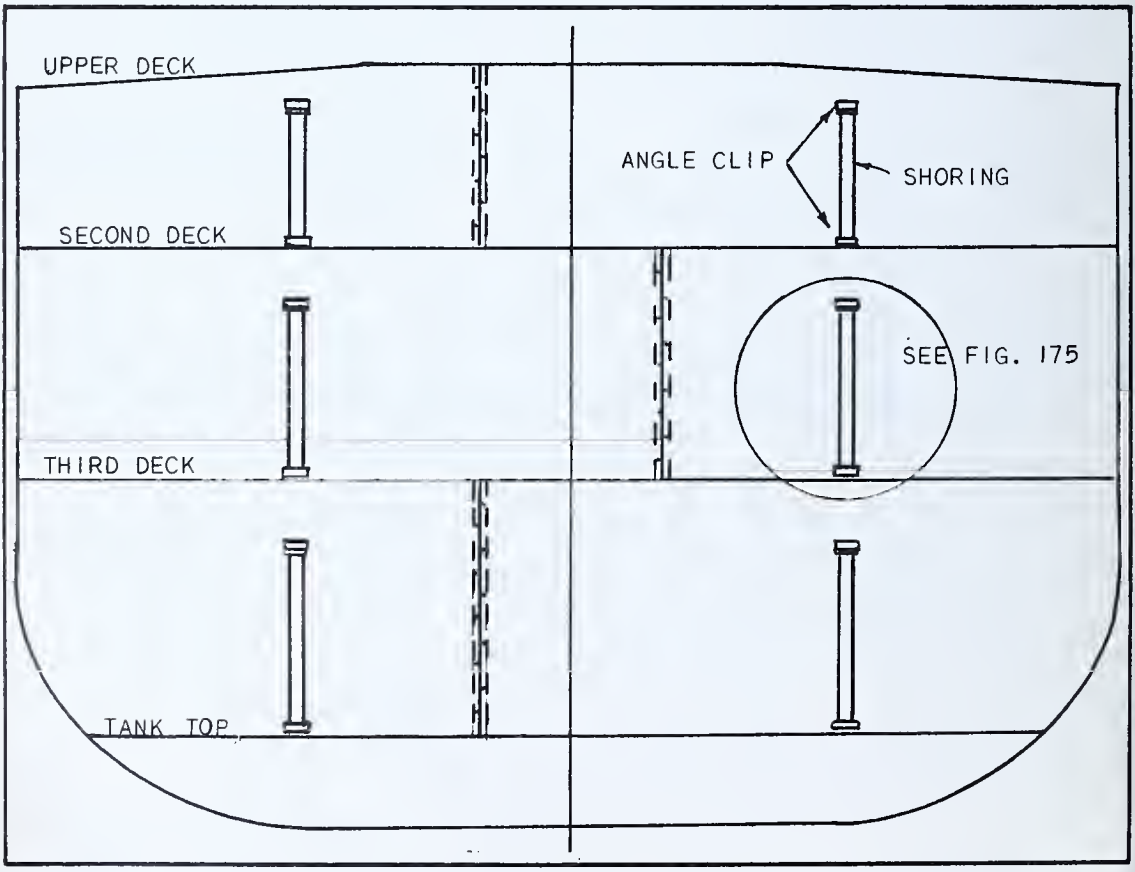


Fig. 174 — *Transverse Bulkheads on Cargo Ships*

have no bolted connections when erected, they must be guyed or shored on both sides as shown in Fig. 175.

Tools and Materials	Equipment
1. Bars	Two ¾″ pennants
2. Maul	Shackles
3. Wrenches	¾″ shackle bolts
4. Guide clips	Ratchets

ADDITIONAL MECHANICS NEEDED: Shipfitter, welder, shipwright or stage-builder.

PROCEDURE

1. Identify and locate assembly to be erected.
2. Shackle pennants to bolt holes near top edge of bulkhead assembly.
3. Signal crane to take bulkhead to point of erection.
4. Have shipfitters strike lines on deck through set marks and have guide dogs welded to the deck.

   Both of these steps should be completed prior to bringing the bulkhead to the point of erection.
5. Position bulkhead at point of erection by means of guide dogs.
6. Have welder attach clips to bulkhead and deck for shoring while bulkhead is held in a vertical position by the crane.
7. Check final position of bulkhead.
8. Have stage builders or shipwrights erect shoring.

   The bulkhead should be shored in a position conforming to the declivity of the shipway.
9. Unshackle pennants.

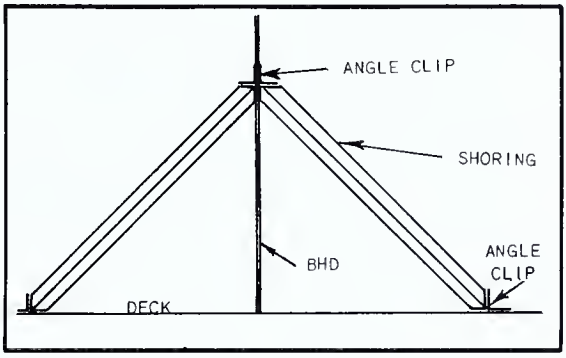


FIG. 175 — *Safe Shoring of Bulkhead*

QUESTIONS

1. **How many sections make up each bulkhead?**
2. **Why must both sides of the bulkhead be shored before unshackling the crane?**
3. **How do these bulkheads differ from tanker bulkheads?**

JOB SHEET NO. 37
ERECTING DECK BEAMS AND LONGITUDINAL GIRDERS

General Information

The hatch end frames consist of web frames at the shell and heavy transverse deck beams which build up to form the hatch ends. (See Fig. 176-A).

The transverse deck beams (Fig. 176-B) usually extend the full width of the ship from shell to shell. Longitudinal girders are erected between the two hatch end beams and form the sides of the hatch.

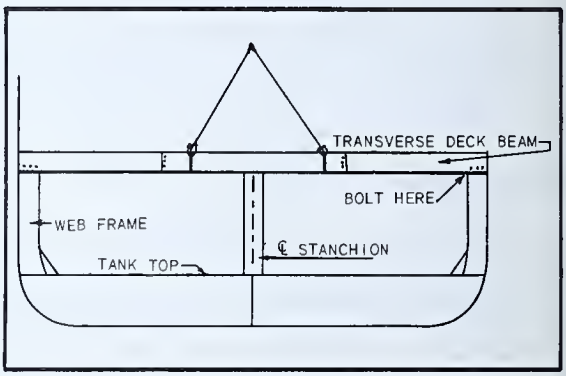


Fig. 176-*A* — *Transverse Deck Beams and Web Frames (Elevation)*

Tools and Materials

1. Two bars
2. Maul
3. Wrenches
4. Drift Pins
5. Bucket of 7/8″ and 3/4″ bolts, nuts, and washers

Equipment

Two 3/4″ pennants 18′ long
Two 3/4″ shackles
Two shackle bolts

Erecting Deck Beams

Procedure

1. Identify and locate members by referring to frame number and deck level (third, second, or upper deck.)

2. Hook the beam to the crane in a horizontal position by passing the pennants around the beam and coupling the shackle to the wire pennant to form a loop. One end should be slightly lower.

3. Signal crane to take the beam to the point of erection.

4. Lower the beam into position, being sure that it is properly placed on the stanchion at the center line. See Fig. 176-A.

5. Temporarily bolt one end, using only one bolt.

6. Bolt opposite end of beam to web frame.

   Spud a matching hole on second end of transverse deck beam, inserting a bolt and tightening. It frequently is necessary to drift these connecting holes into alignment. Full size bolts should be used in making up these connections.

7. Unshackle pennants.

Erecting Longitudinal Girders

PROCEDURE

1. Identify and locate girder by referring to extreme frame numbers and the deck level (third, second, or upper deck.)

2. Shackle pennants to girder by wrapping the pennants around the girder and then passing the pennant through the shackle onto the hook. The girder should be low at the after end, so that it will conform to the declivity of the shipway. The top side should face upward.

3. Signal crane to take girder to point of erection.

4. Lower the girder into place.

5. Bolt connection at one end of girder. This is a temporary connection, using one bolt. See Fig. 176-B.

6. Bolt other end of girder into place.

   If it is difficult to align holes, bars may be used to pry the girder into place, or a wedge may be driven between the girder and the deck beam.

7. Connect the girder securely by bolting the three-hole clip angles on the girders to the deck beams. Use full size bolts in every hole.

8. Unshackle pennants.

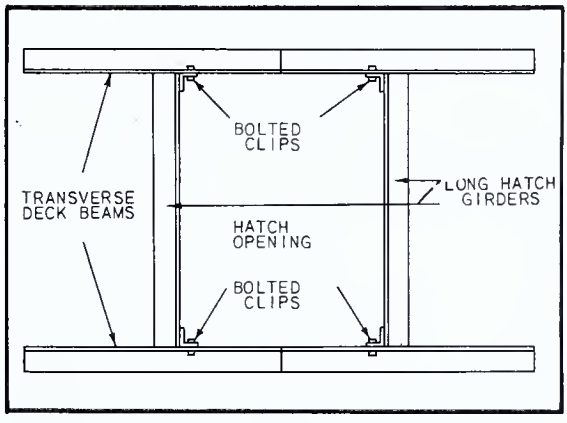


FIG. 176-*B* — *Longitudinal Girders and Connections to Transverse Beams. (Plan View)*

QUESTIONS

1. Describe the point of erection of a deck beam marked $\frac{\text{2nd Dk}}{110}$
2. Why does handling the beam with one end low make it easier to bolt the connection?
3. How will the connection be made, if, when one end is connected, the other end does not meet the connection holes?
4. How is the exact position of the beam over the stanchion determined?
5. Why should the longitudinal girder be hooked with the after end low?
6. How may a steel wedge be used in forcing a girder into place?
7. What size bolts should be used in all connections?

JOB SHEET NO. 38
ERECTING SHELL PLATES BY "IN AND OUT" METHOD

General Information

The shell plating on a cargo ship having riveted construction usually is fastened on vertical frames by the "in and out" plating method, as shown in Fig. 177. Some shipyards erect all "in" (inside lap) plates before hanging the "out" (outside lap.) Also, some yards start erection at the bilge and progress upward, hanging the next upward strake of plates, whether it is "in" or "out". Erection usually is started at the bilge or "E" strake of plates. If the "E" is an "in" strake, the "F" will be an "out", the "G" will be an "in", the "H" will be an "out", the "J" will be an "in", and the "K" will be an "out". Usually the "K" is the topmost strake of plates (the sheer strake.) The number of strakes of plates is entirely dependent upon the size of the ship and the width of the plates. All ships are not alike. All "out" plates will have liners between the frame and the plate, unless the plate or the frame is joggled, as shown in Fig. 177.

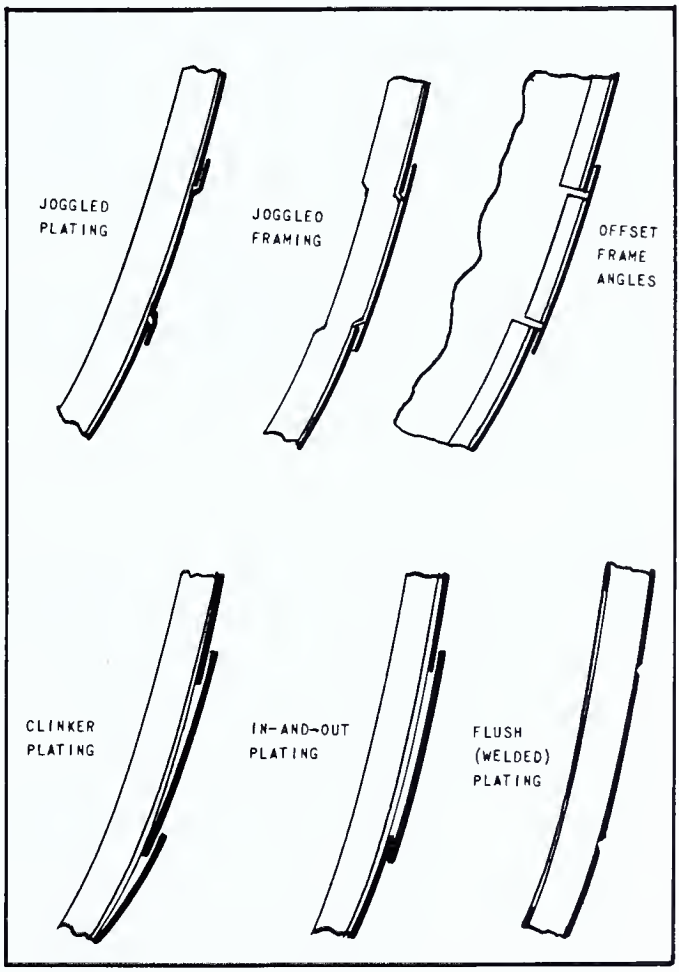


FIG. 177 — *Arrangements of Shell Plating*

Tools and Materials

1. Two bars
2. One maul
3. Erector's wrenches
4. Pneumatic wrench
5. Drift pins
6. Bolts, nuts and washers
7. Red lead paint and brush

Equipment

Crane
Two ¾″ pennants
Two shackles
Two ¾″ shackle bolts
Shell Wire

Erecting All "In" Plates

PROCEDURE

1. Identify and locate the plates by referring to frame numbers, strake letter, and port or starboard markings.

2. Shackle pennants to top of "E" plate so that the after end will be slightly heavy, thus providing for the declivity of the shipway. Do not shackle the plate in a frame hole since so doing will interfere with the erection of the plate.

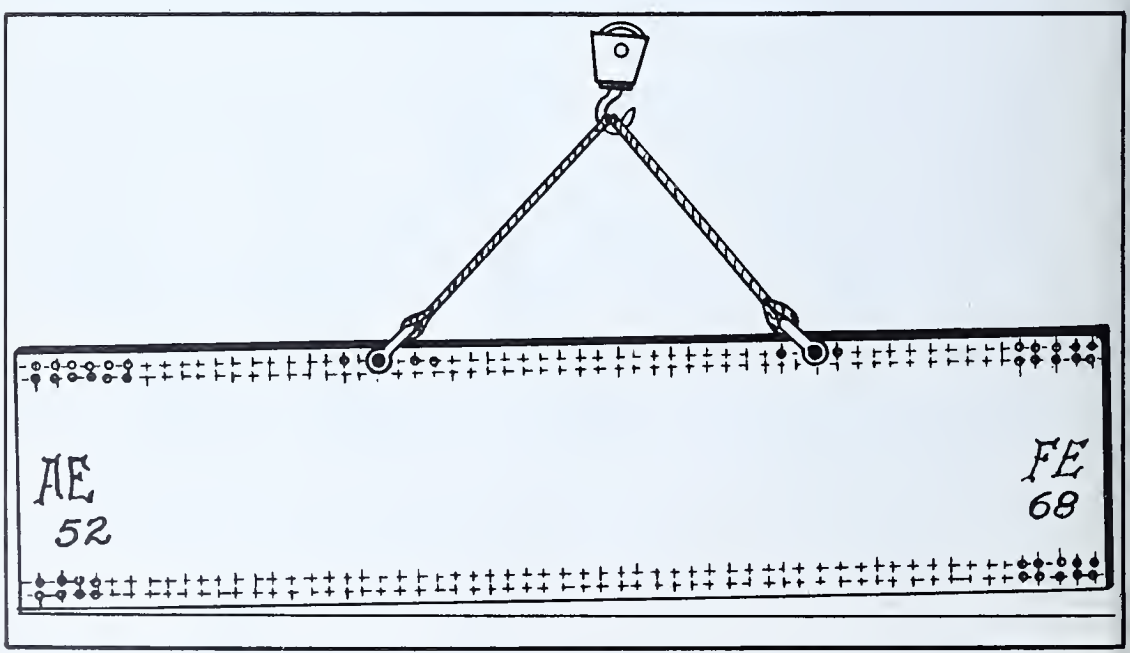


FIG. 178 — *Handling Shell Plate to Provide for Declivity*

3. Paint all connecting surfaces with red lead.

4. Signal crane to take plate to point of erection.

5. Lower the plate down the side of the ship to the proper strake.

   Guide the plate past the staging so that the plate does not catch on the spawls, planks, or other objects while it is being lowered. The top man (signal man) will

carefully watch the two men at the ends of the plate for signals and also see that the crane block does not catch on any obstruction.

6. Bolt the plates to the frame and tighten, using a pneumatic wrench.

   When possible the plates are bolted to the web frames, in that these frames provide the strongest connection. Use only sufficient bolts to hold the plate securely in position. Do not place bolts in that part of the plate seam which will be covered by the next plate.

7. Unshackle pennants.

8. Paint seams of inside plate at point of contact with outside plates (faying surfaces.)

Erecting All "Out" Plates

PROCEDURE

The "out" plates are handled and placed in the same manner as that used in erecting the "in" plates. When bolting the "out" plate in place the bottom seam is first bolted at each end. The nuts are then removed from the shackle bolts, so that the shackle bolts may be easily removed after the plate has been bolted to the frame. Bolt the "out" plates securely to the seams of the previously erected "in" plates. Bolts should not be placed through the frames to the "out" plates until the liners are installed. As soon as possible a hand gang should follow the erectors and install the liners.

QUESTIONS

1. **What is "in and out" shell plating?**
2. **How is a plate marked to determine its location?**
3. **Why do we paint connecting surfaces?**
4. **Why should we not bolt to a frame in a seam hole?**
5. **When should bolts be placed through the frames on "out" plates?**
6. **Why are all "in" plates erected first?**
7. **What is the "sheer strake"?**

JOB SHEET NO. 39
ERECTING SHELL PLATES BY "PROGRESSIVE" METHOD

General Information

The "E" and "F" strakes of plates are erected by following the procedure indicated in Job Sheet No. 38.

Tools and Materials

1. Two bars
2. One maul
3. Erectors' wrenches
4. Pneumatic wrench
5. Drift pins
6. Bolts, nuts, and washers
7. Red lead paint and brush

Equipment

Crane
Two ¾" pennants
Two shackles
Two ¾" shackle bolts
Shell wire

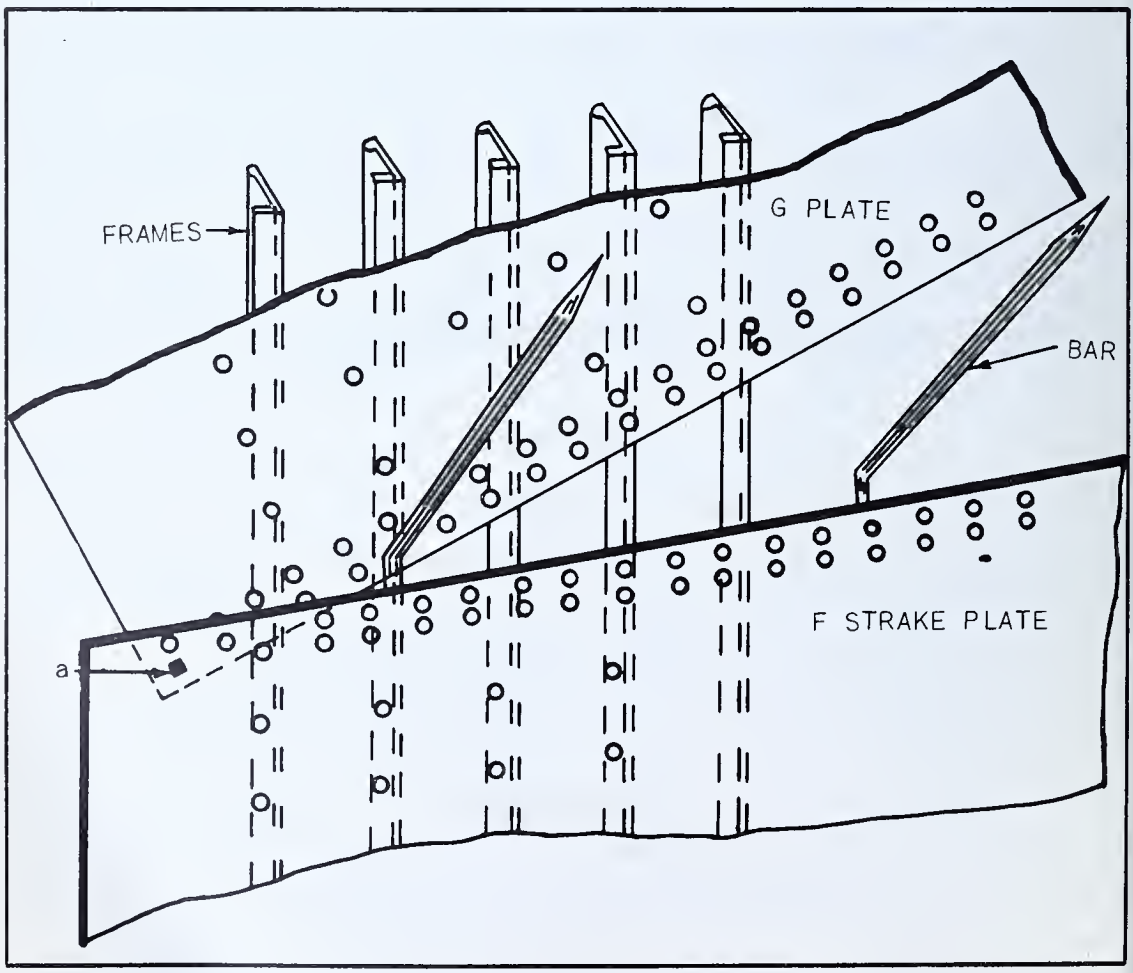


Fig. 179 — *Shearing "G" Plate Into "F" Plate*

PROCEDURE

1. Identify and locate plate by referring to frame numbers, strake letter, and port or starboard markings.
2. Shackle pennants to top of the "G" plate, so that it will hang low at the *forward end.*

   This will permit the plate to be "sheared" into the "F" plate. Do not shackle to the plate in a frame hole since so doing will interfere with the erection of the plate.
3. Paint all connecting or faying surfaces with red lead.
4. Signal the crane to take the plate to the point of erection.
5. Lower the "G" plate down the side of the ship so that the holes in the lower forward end will line up with the correct holes in the "F" plate and frame. Spud the holes into alignment.
6. Insert a bolt through one of the end holes "a," in Fig. 179, where the plates meet, but do not tighten it.
7. Signal the crane to lower the plate slowly into the seam of the "F" plate. Fig. 179.

   This is termed "shearing the plate in." It may be necessary to "cut the plate in" when the "G" plate is entered inside the seam of the "F" plate. "Cutting the plate in" is done by placing the sloped heel of the bar over the edge of the "F" plate and then permitting the "G" plate to slide down the bar so that it will enter into the position desired. See Fig. 179.
8. Spud or drift holes in plates.
9. Bolt the "G" plate securely in position at the "F" plate seams and frames, using full-size bolts and tightening with a pneumatic wrench.
10. Unshackle pennants.

QUESTIONS

1. **What is meant by "Progressive Method"?**
2. **Why must we not shackle to a frame hole?**
3. **What is meant by "shearing in" a plate?**
4. **How do you use the bars to "cut in" the plate?**
5. **How is an "in" plate bolted into place?**
6. **How is the exact point of erection determined?**
7. **How is an "out" plate bolted into place?**
8. **Why should the "out" plate be loosely bolted to the frames?**
9. **When seam holes do not align properly, how can a drift pin be used in aligning holes?**

JOB SHEET NO. 40
ERECTING SHELL PLATING BY STARTING AT THE TOP

General Information

Two methods of erecting riveted shell plating are described in job sheets 38 and 39. Job sheet 38 presented the "In and Out" method. Job sheet 39 described the "Progressive" method. A third method, beginning at the top and working toward the bottom, is used in erecting combination riveted and welded tankers having either longitudinal or vertical framing.

Fig. 180 — *Riveted Shell Plating*

The sequence of Erecting Shell Plating Using "Top to Bottom" method is as follows:

1. Erect sheer strake (usually "K" strake)

   The sheer strake is the topmost strake, as shown in Fig. 181.

2. Erect "H" strake

   "H" strake is the first "in" strake down from the top. Fig. 181.

3. Erect "J" strake

   The "J" strake, an "out" strake connects the "H" and "K" strakes, completing erection of the three topmost strakes.

4. Erect "F" strake

   The "F" strake is the lower "in" strake; it is erected before the "G" strake.

5. Erect "G" strake

6. Fig. 182 illustrates a method of erecting riveted shell plates, beginning at the top and working down. In this illustration the "K" strake of the shell is shown as having been erected. The top of the bulkheads, ending at the

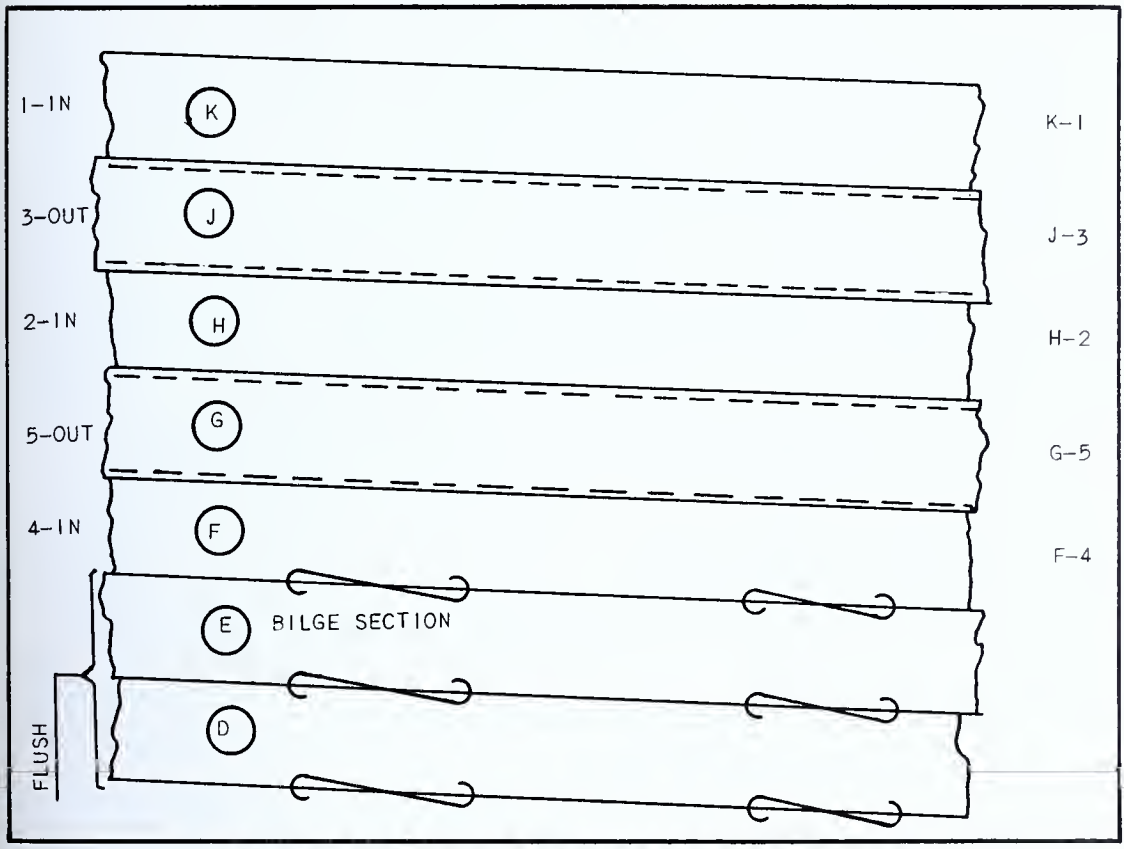


FIG. 181 — *Sequence in Erecting In and Out Plates*

bottoms of the plates of the "K" strake, have been welded at "b". These plates also are bolted at the frame line at the shell longitudinal at "a". The "H" strake is erected by bolts only, being bolted in the shell longitudinals at the frame line at "c". In Fig. 182 the shell plate "H8" is shown in a position which is out of line. Note the butt seam and overlap on plate "H9". This condition is caused by the frames which are bent or sagged out of line owing to the weight of the other plates.

The plate marked "J5" has been erected and is held in place by bolts at both top and bottom. The plate "J5" being bolted in its correct position, also causes the plate "H7" to be lined to its proper position. To erect the "J6" plate and to line up the "H8" plate at the same time, the "J6" plate is lowered into place and the connection bolted in the top right hand corner of the plate at "d". The "J6" plate is then lowered until the holes in the lower seam are in line with their proper erection holes at "e". These two corners are now bolted with at least two bolts in each corner. The plate "J6" is now raised with the crane until the top and bottom seams of this

plate are in line for the full length of the plate. Both seams can now be bolted, the bottom seam being fastened first so that the crane may be unhooked.

The procedure described above must be modified to suit the conditions of the previously erected steel.

Tools and Materials	Equipment
1. Two bars	Crane
2. One maul	Two ¾″ pennants
3. Erectors' wrenches	Two shackles
4. Pneumatic wrench	Two ¾″ shackle bolts
5. Drift pins	Shell wire
6. Bolts, nuts, and washers	
7. Red lead paint and brush	

Erect the "K" Strake of Plates

PROCEDURE

1. Identify and locate the "K" plate.
2. Shackle the pennants to the top edge of "K" plate so that the after end is slightly low, thus providing for the declivity of the shipway.
3. Signal the crane to take the plate to the point of erection.
4. Spud the holes "a", Fig. 182, in to proper alignment at the correct frames.
5. Bolt the plate into position on the frames.
6. Have the plate welded to the bulkhead "b", Fig. 182, at the water line and bulkhead set lines.
7. Unshackle pennants.

Erect the "H" Strake of Plates

The "H" plate, Fig. 182, is erected in the same manner as the "K" plate, except that the "H" plate is bolted only at "c", and not welded.

Erect the "J" Strake of Plates

8. Identify and locate the "J" plate.
9. Shackle pennants to "J" plate.

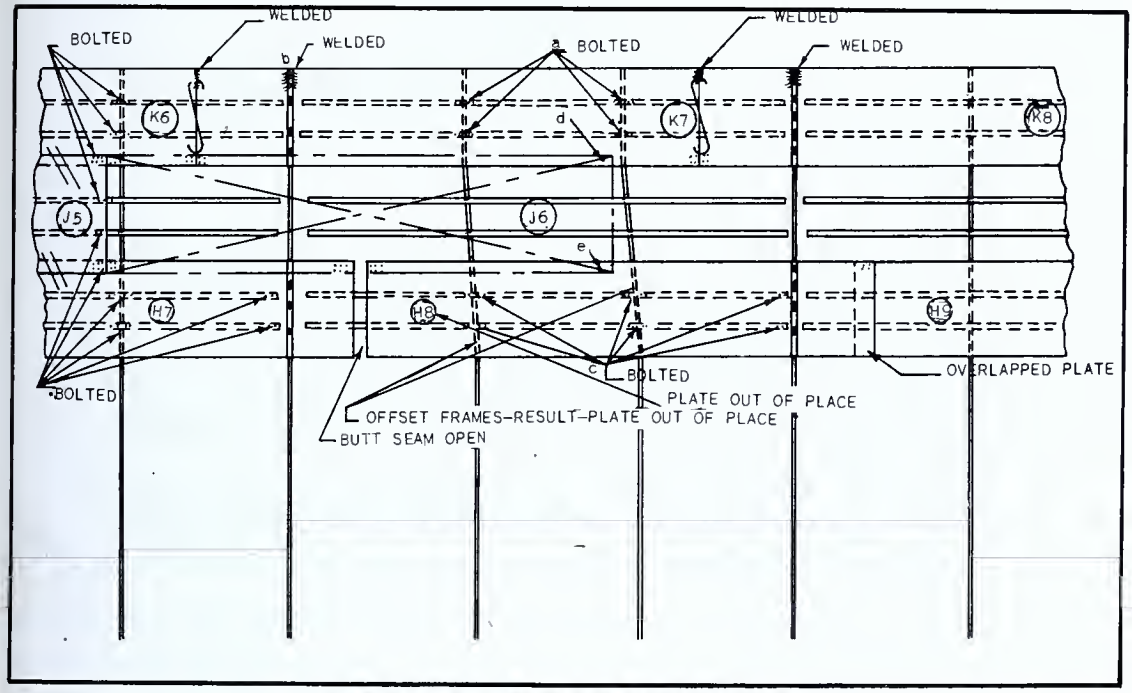


FIG. 182 — *Erecting Shell Plates*

10. Signal crane to take plate to point of erection.

11. Spud the proper hole, "d", Fig. 182, at the top right-hand corner of the "J" plate.

12. Bolt hole "d" at top right hand corner of "J" plate to lower part of "K" plate.

13. Raise or lower plate until the proper hole "e", Fig. 182, can be spudded at the lower right hand corner of the "J" plate.

14. Tightly bolt the two corners, "d" and "e".

15. Raise or lower plates until remaining seam holes are in line.

16. Bolt the connections along the seam where the "H" and "J" plates meet.

17. Unshackle pennants.

18. Bolt the top seam of the "J" plate.

Erect the "F" plate in the same manner as that used in the placing of "H" plate.

Erect the "G" plate in the same manner as the "J" plate.

QUESTIONS

1. What is the sequence of erection when using the "top to bottom" method?
2. How is the "K" strake fastened?
3. How is the "H" strake fastened?
4. What condition may cause the "H" plate to be out of line?
5. How may we align this out-of-line plate while erecting the "J" strake?
6. What is the order of the bolted connections when bolting the "J" strake?
7. Could the same condition be encountered while erecting the "F" and "G" strakes?

JOB SHEET NO. 41
SHELL LINER INSTALLATION

General Information

On ships that are vertically framed and have riveted shell construction, it is necessary to place liners back of all "out" plates when "in and out" plating methods are used. This liner is used to fill the space between the "out" plate and the frame. The liner must be of the same thickness as the "in" plates which are on both sides of the "out" plate. If one of the "in" plates is thicker than the other, a tapered liner must be used, the liner being the thickness of one "in" plate on one end, and tapering to the thickness of the other "in" plate on the other end.

Liners used in oil carrying cargo spaces are not coated with red lead before erecting, although those which occur in dry cargo spaces or forepeaks, afterpeaks, or ballast tanks, will be coated with red lead paint before erecting.

Liners are sorted and places in piles, each shell strake being placed in a separate pile. The numbers inclusive from one bulkhead to another are usually piled separately. Thus, the liners for the "K" strake from bulkhead 110 to bulkhead 125 may be placed in one pile. There will be two liners of each number, one for port, and one for starboard sides. Liners are hooked to the crane as shown in Fig. 46, and taken to the deck or hold nearest to their location.

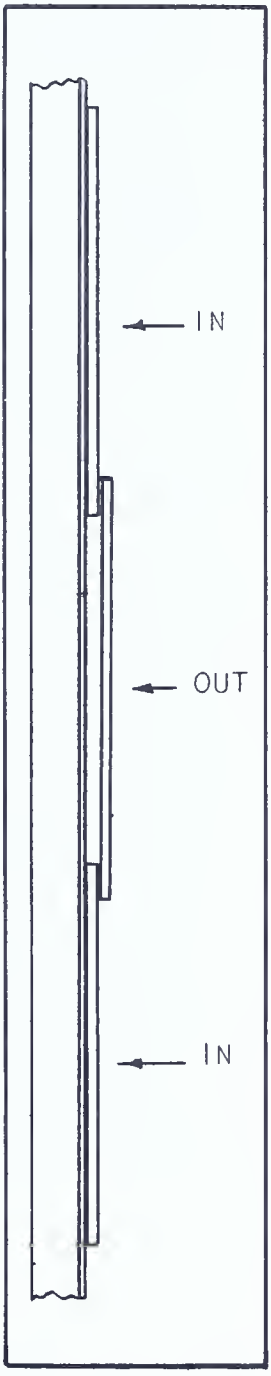


FIG. 183 — *"In and Out" Plating*

Tools and Materials

1. Wrenches
2. Maul
3. Steel wedges
4. Drift pins
5. Piece of flat plate
6. Paint pot and brush. (Red lead)
7. Nuts from 7/8" bolts
8. 3/4" bolts, nuts and washers
9. Pneumatic (knock-knock) wrench

Equipment

3/4" wire rope pennants

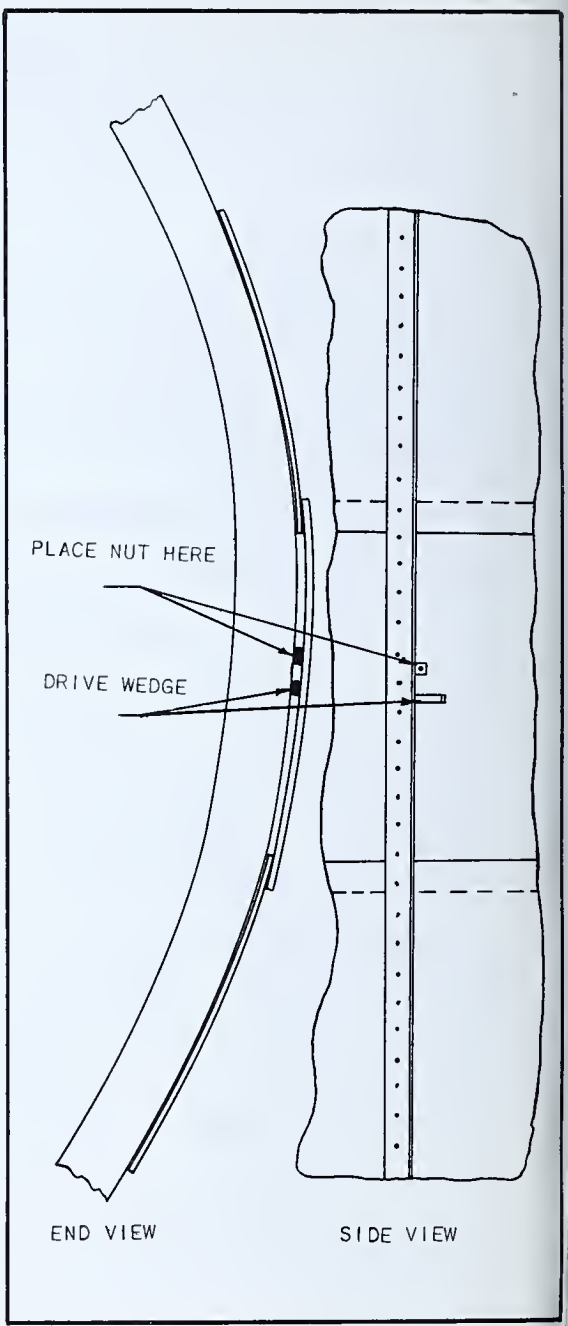


FIG. 184 — *Wedge and Nut Used to Assist in Installing Liner*

PROCEDURES

1. Place each liner along side of its respective frame. (Strake letter and frame No.)
2. Paint liners on both sides, being careful not to paint out the markings on the liner. Markings which remain showing are, strake letter, frame No., and top.
3. Drive steel wedge into space for liner until space is open to a greater width than the thickness of the liner.
4. Place a 7/8" nut in space wedged open and knock out steel wedge.
5. Paint unpainted parts of liner. (Markings.)
6. Insert liner with "top mark" to top and place point of spud wrench or drift pin into the top hole. (Fig. 185, Installing liner.)

7. Use piece of flat iron and maul to drive liner into place. As liner is forced into place by blows from the maul, the liner will force the 7/8" nut out as it strikes the nut.
8. Place two bolts through the frame liner and shell plate, (one at top and one at bottom) and bolt up tightly.

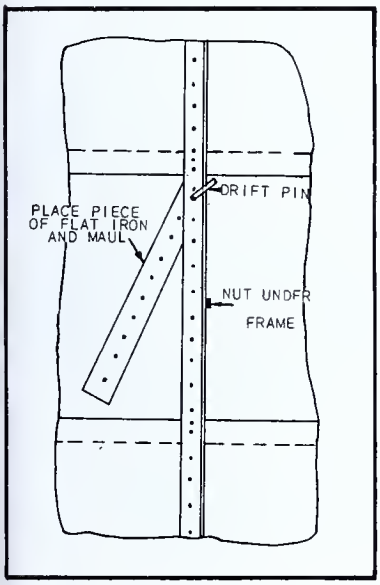


FIG. 185 — *Installing Liner*

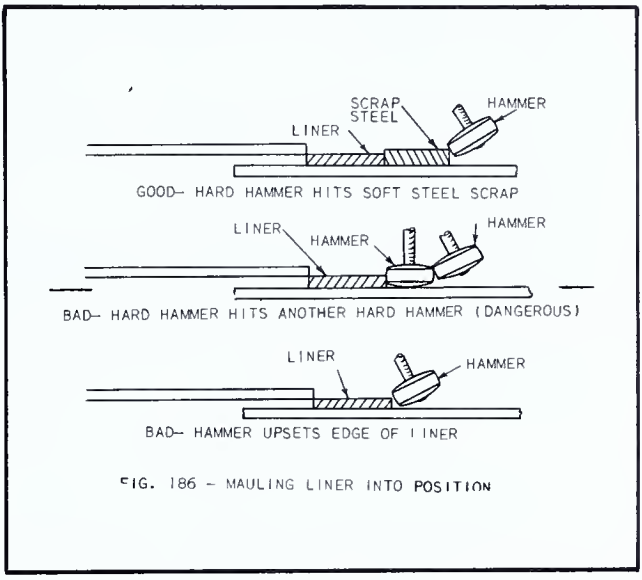


FIG. 186 — *Mauling Liner Into Position*

QUESTIONS

1. **Would shell liners be used on ships having longitudinal shell framing?**
2. **Should the entire liner be painted before erecting? Why?**
3. **Why should we never strike the edge of a liner with a maul to drive it into place?**
4. **How can we use a 7/8" nut with a steel wedge to help make liner installation easier?**
5. **After a liner is inserted, how should it be fastened?**

Part X

BLUEPRINT READING FOR SHIP ERECTORS

The ship erector must be capable of reading hull drawings in sufficient detail to identify any part to be erected, and to determine the exact place of erection of any assembly or piece.

The location of brackets (of which there are approximately 1400) is an important blueprint reading job for the erector.

A ship erector must learn to locate lines.

1. *Center line.* Longitudinal bulkheads are located a certain number of feet off center line and extend between stated frame numbers.

2. *Frame lines* and any *measurement off frame lines.* Transverse bulkhead locations occur on frame lines.

3. *Base Line.* A line running from bow to stern.

4. *Water lines.* Heights above base lines are termed *water lines.*

5. *Plate markings.* These markings are located fore and aft by frame lines or frame numbers, and are located vertically on shell expansion drawings by means of strake letters (A, B, C, etc.)

In that the location of practically all erecting jobs is determined from frame numbers, it is important that the erector thoroughly understand the system of frame numbering, and be capable of locating longitudinal positions by reference to frame numbers.

Transverse locations are found by measuring outboard from the center line. Such measurements may be termed buttocks.

Conventional Lines Used in Ship Hull Drawings

Border lines are heavy, full lines, used as a border for a drawing.

Full lines are solid, continuous lines used as boundary or visible edge lines.

Dotted lines used to denote invisible edges or hidden surfaces.

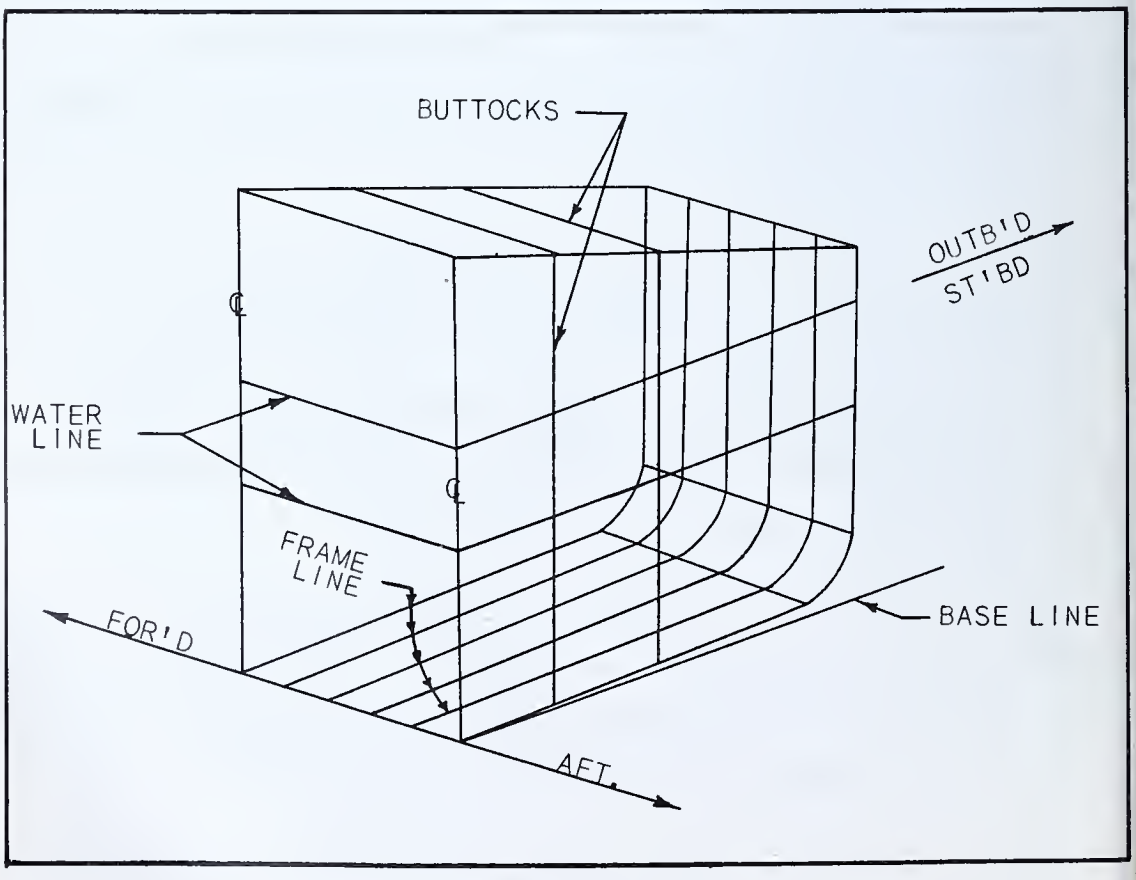
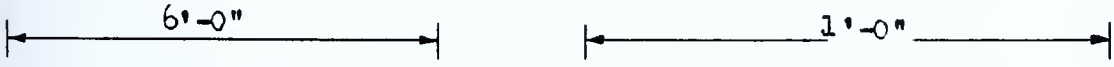


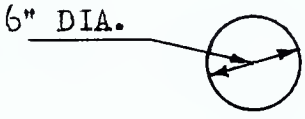
FIG. 187 — *Diagrammatic View — Lines of a Ship*

Section lines, which may be either light, solid lines, or long uniform dashes, show the point at which a section view is taken; the direction of the view is shown by the short lines terminating in arrow-heads.

Dimension lines are light, solid lines drawn parallel to the direction of measurement with small arrow-heads on each end, sometimes divided at some point to allow insertion of dimensions.



Reference lines are light, solid lines generally oblique (slanting) used to point out special features on a drawing.



Invisible plate lines are heavy, dotted lines with light, solid lines on both sides.

Dot and dash lines are used to denote invisible edges, center line, and base line.

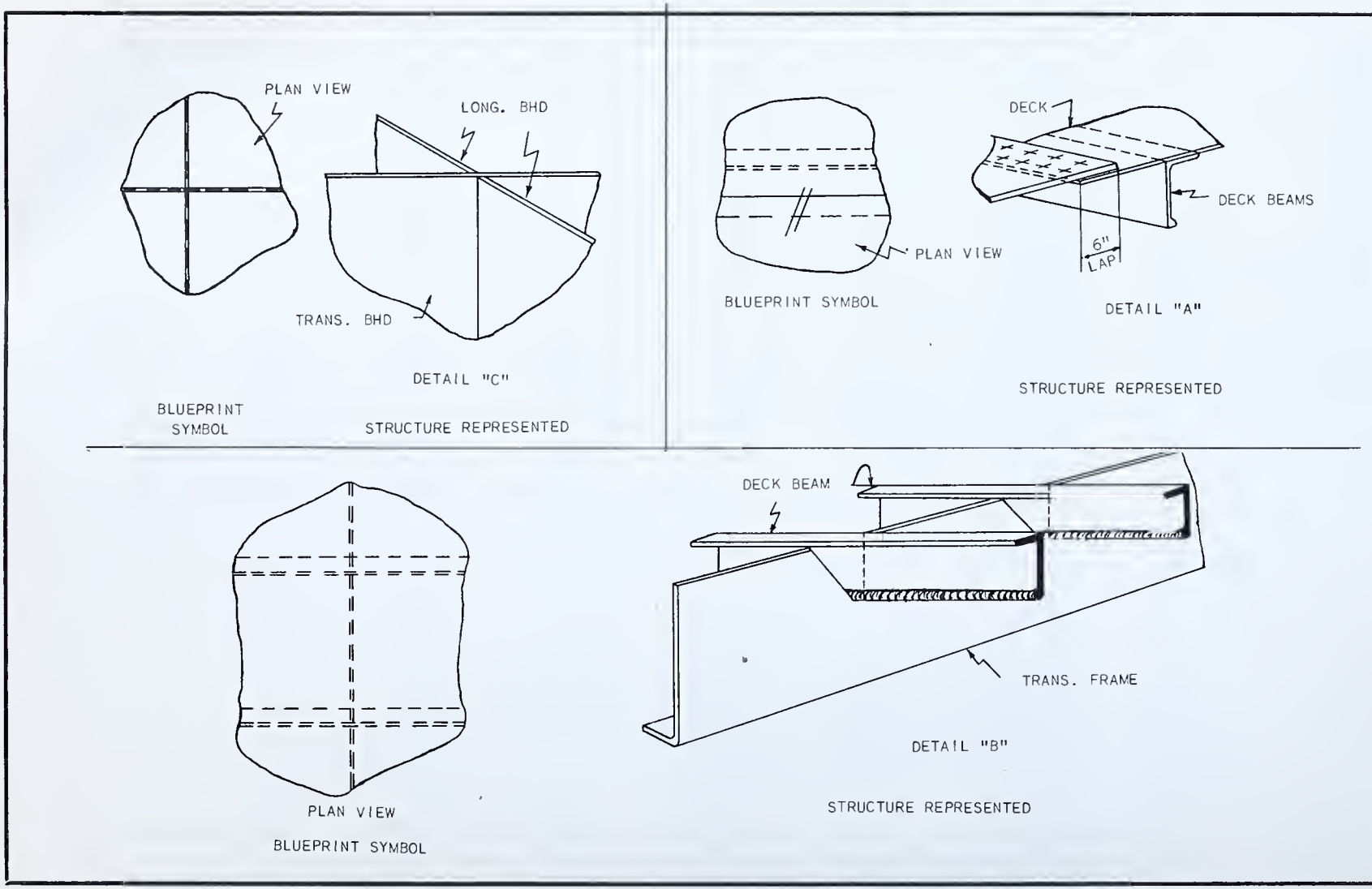


FIG. 188 — *Representing Structures by Means of Symbols*

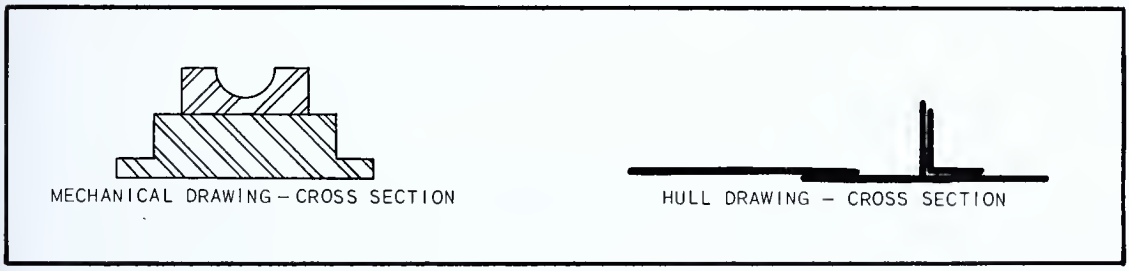


FIG. 189 — *Essential Differences Between a Cross Section of a Hull Drawing and That of a Mechanical Drawing*

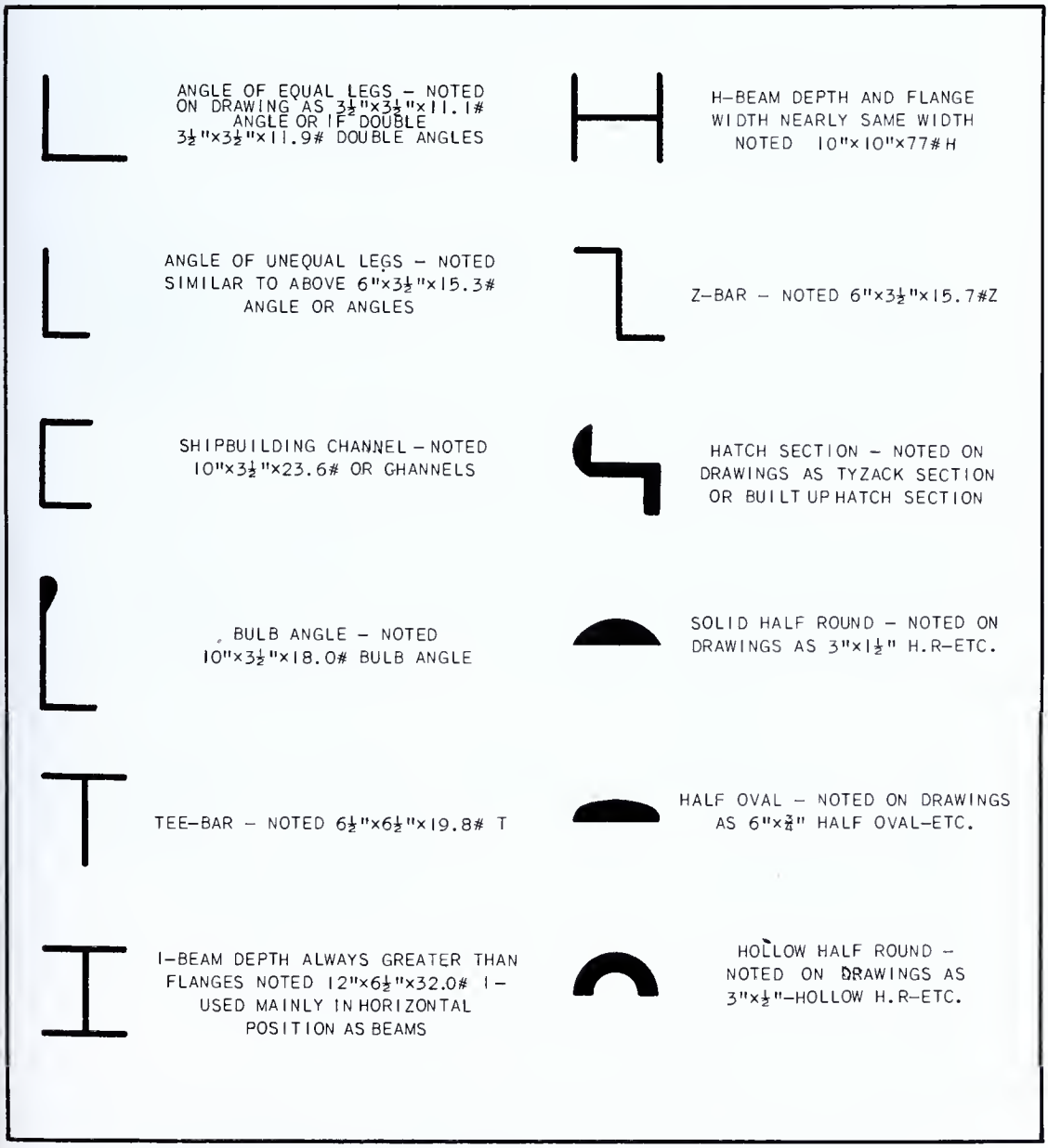
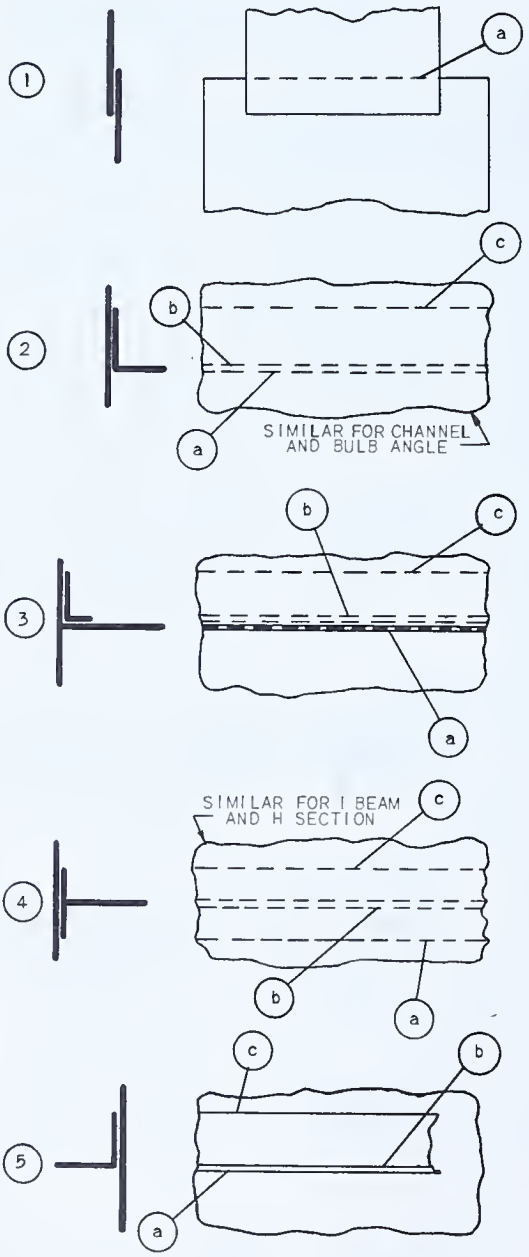

ANGLE OF EQUAL LEGS – NOTED ON DRAWING AS 3½"×3½"×11.1# ANGLE OR IF DOUBLE 3½"×3½"×11.9# DOUBLE ANGLES
H–BEAM DEPTH AND FLANGE WIDTH NEARLY SAME WIDTH NOTED 10"×10"×77# H
ANGLE OF UNEQUAL LEGS – NOTED SIMILAR TO ABOVE 6"×3½"×15.3# ANGLE OR ANGLES
Z–BAR – NOTED 6"×3½"×15.7#Z
SHIPBUILDING CHANNEL – NOTED 10"×3½"×23.6# OR CHANNELS
HATCH SECTION – NOTED ON DRAWINGS AS TYZACK SECTION OR BUILT UP HATCH SECTION
BULB ANGLE – NOTED 10"×3½"×18.0# BULB ANGLE
SOLID HALF ROUND – NOTED ON DRAWINGS AS 3"×1½" H.R–ETC.
TEE–BAR – NOTED 6½"×6½"×19.8# T
HALF OVAL – NOTED ON DRAWINGS AS 6"×¾" HALF OVAL–ETC.
I–BEAM DEPTH ALWAYS GREATER THAN FLANGES NOTED 12"×6½"×32.0# I – USED MAINLY IN HORIZONTAL POSITION AS BEAMS
HOLLOW HALF ROUND – NOTED ON DRAWINGS AS 3"×½"–HOLLOW H.R–ETC.

FIG. 190 — *Sections Involved in Structural Drawings*



Explanation

1 — Denotes a plate lap. The dotted line (a) indicates the section of plate that is invisible.

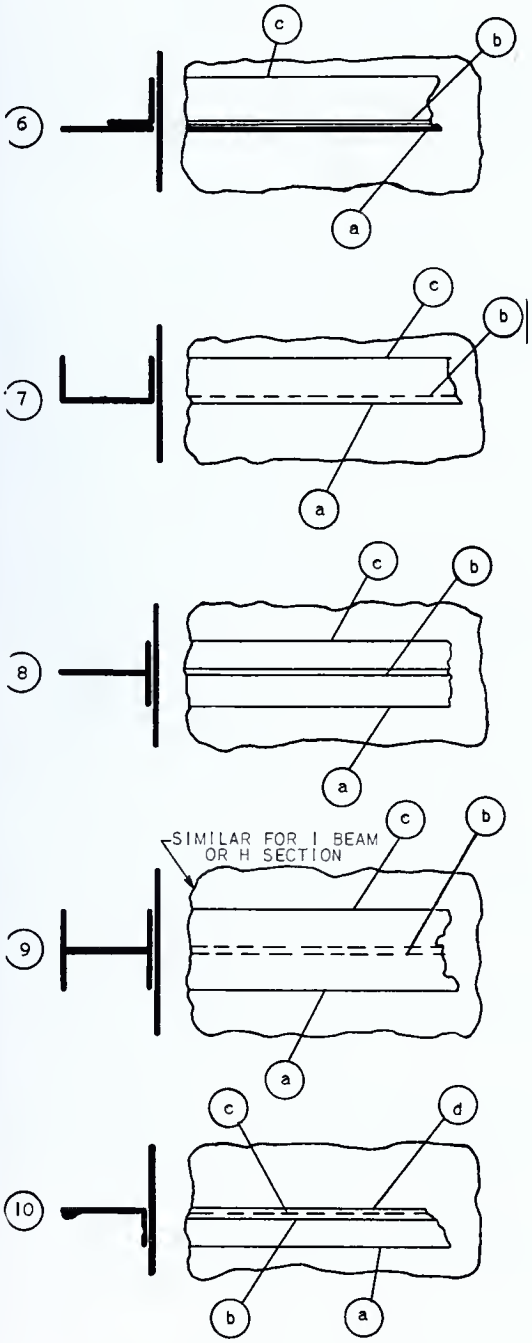
2 — Denotes an angle under a plate. (a) indicates the heel, (b) the bosom, and (c) the toe of the angle.

3 — Denotes an angle and a plate. (a) indicates the invisible plate and heel of the angle, (b) the bosom, and (c) the toe of the angle.

4 — Denotes a tee-bar under a plate. (a) indicates the toe of the tee-bar, (b) the standing flange, and (c) the other toe of the tee-bar.

5 — Denotes an angle on a plate. (a) indicates the heel, (b) the bosom, and (c) the toe of the angle.

FIG. 191 — *Method of Showing Various Shapes on Drawings*



Explanation

6 — Denotes an angle and a plate on a plate. (a) indicates the plate and the heel of the angle, (b) the bosom, and (c) the toe of the angle.

7 — Denotes a channel on a plate. (a) indicates the heel of the channel, (b) the bosom, and (c) the toe of the channel.

8 — Denotes a tee-bar on a plate. (a) indicates the toe of the tee-bar, (b) the standing flange, and (c) the other toe of the tee-bar.

9 — Denotes an I Beam on a plate. (a) indicates the toe of the I Beam, (b) the web, and (c) the other toe of the I Beam.

10 — Denotes a bulb angle on a plate. (a) indicates the toe of the angle, (b) the bulb, (c) the bosom, and (d) the heel of the bulb angle.

FIG. 191-*A* — *Method of Showing Various Shapes on Drawings*

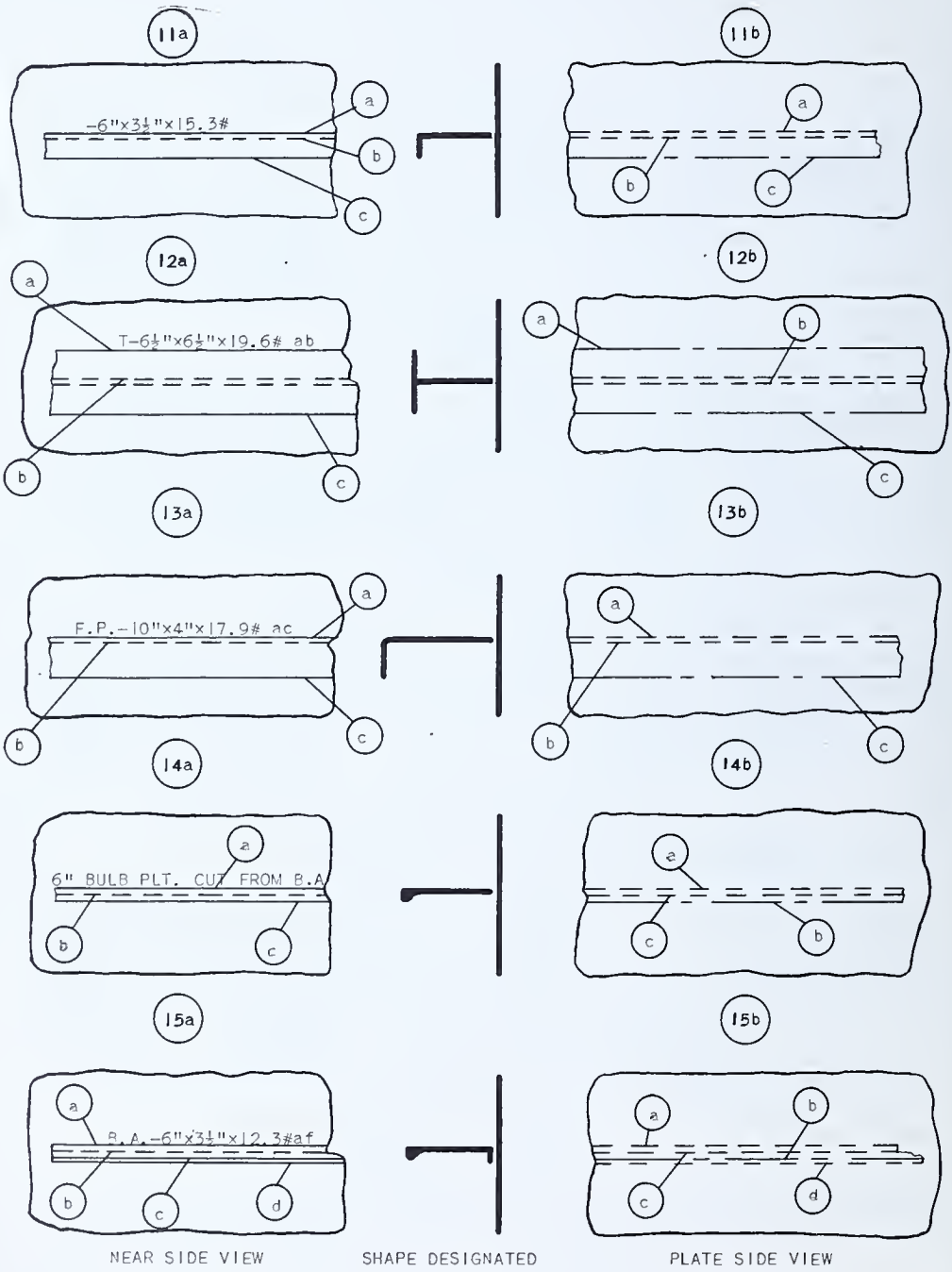


FIG. 191-*B* — *Method of Showing Various Shapes on Drawings*

Explanation of Figure 191-B, Illustrations of Blueprint Symbols

11a — Denotes an inverted angle on a plate. (a) indicates the heel, (b) the bosom, and (c) the toe of the angle.

11b — Denotes an inverted angle under a plate. (a) indicates the heel, (b) the bosom, and (c) the toe of the angle.

12a — Denotes an inverted tee-bar on a plate. (a) indicates the toe, (b) the standing flange, and (c) the other toe of the tee-bar.

12b — Denotes an inverted tee-bar under a plate. (a) indicates the toe, (b) the standing flange, and (c) the other toe of the tee-bar.

13a — Denotes a flanged plate on a plate. (a) indicates the heel, (b) the bosom, and (c) the toe of the flanged plate.

13b — Denotes a flanged plate under a plate. (a) indicates the heel, (b) the bosom, and (c) the toe of the flanged plate.

14a — Denotes bulb plate (cut from bulb angle) on a plate. (a) indicates the heel, (b) the bosom, and (c) the bulb of the plate.

14b — Denotes bulb plate (cut from bulb angle) under a plate. (a) indicates the heel, (b) the bosom, and (c) the bulb of the plate.

15a — Denotes a bulb angle on a plate. (a) indicates the heel, (b) the bosom, (c) the bulb, and (d) the toe of the bulb angle.

15b — Denotes a bulb angle under a plate. (a) indicates the heel, (b) the bosom, (c) the bulb, and (d) the toe of the bulb angle.

WORK ASSIGNMENTS

BLUEPRINT READING FOR SHIP ERECTORS

(Figures 192 - 203 refer to reproductions of blueprints included in the separately - bound supplement to this book entitled "Blueprint Reading for Ship Erectors")

Fig. 192 — Transverse Bulkhead

1. How many type "C" brackets are attached to each bulkhead? What is the size of these brackets?
2. Which of these goes in the wing tank forward of the bulkhead — CK, CM, CN, or CP?
3. In what tank does each bracket go? How many brackets are in each tank?
4. On which side of face plate "CA — CB" is the lap of the longitudinal bulkhead placed?

Fig. 193 — Center Line Vertical Keel and Center Deck Girder

1. Locate bracket marked "AA" and give size.
2. How does the center line vertical keel connect to the bulkhead at 56? At 59?
3. Locate plate "ba" and "bd".

Fig. 194 — Shell Expansion

1. What frames do the ends of shell plate "J11" adjoin?
2. How do the seams lap on shell plate "H10"?
3. Locate longitudinal 21/56 - 59. Which way does it heel?
4. What is the measurement from O to the nearest frame?
5. What longitudinals receive tripping brackets 4" x 7/16"? What ones receive 6" x 7/16"? Where are they located?
6. Which plates have butt seams? Which plates have lapped seams?

Fig. 195 — Transverse Frame No. 69

1. On which side of the frame are the tie beams connected?
2. On which shell longitudinals do brackets "BB" connect?
3. How are the shell plates fastened to this frame?
4. How would bracket "bb" at longitudinal 14 be marked?

Fig. 196 — Transverse Frame No. 45

1. Where is the base of stanchion "BX" located? On what frame number?
2. What brackets occur at "Long. No. 9"? How wide are they?
3. On which side of deck beam "AM" does the web frame fasten?

Fig. 197 — Forepeak Frames, Floors and Breasthooks

1. Locate the "2' - 0"Buttock" on frame 56.
2. Does plate "DB" connect on the forward or the after side of plate "DA"?
3. How does plate "DF" fasten to the second deck?
4. How would the intercostal plates, type "gn", be marked?

Fig. 198 — Upper Deck Plating

1. What are the dimensions of plate "UD/B8"?
2. What is the weight of plate "UD/D6"?
3. What type of plate lapping is used on this deck?
4. Locate the ends of plate "UD/E8" in relation to frames.

Fig. 199 — Oil Tight Longitudinal Wing Bulkhead

1. What is the dimension between frames?
2. On which side of the face plates at 56 and 59 does the T-bar connect?
3. How much does the T-bar lap?
4. Do the flange plate frames 57 and 58 toe forward or aft?

Fig. 200 — Bulkheads on Upper Deck Forward

1. How does plate "ach" connect to shell web frame? Locate the "9′ - 0″ Buttock" on frame 97.
2. Does frame 97 flange toe forward or aft?
3. How far off center line is plate "A - C - M"?
4. On what frames does plate "A - C - B" cross?

Fig. 201 — Longitudinal and Transverse Engine Casings

1. To what brackets do the longitudinal casings fasten?
2. How far does the casing extend below the upper deck?
3. Between what frames does the casing erect?
4. How does the transverse casing connect to the longitudinal casing?

Fig. 202 — Forward Stringers

1. Does plate "dd" of stringer No. 3 flange up or down?
2. Does bracket "bm" connect on the under side or the upper side of the stringer?
3. Which stringer is the one nearest the bottom of the ship?
4. What is the plate mark on the breast hook of stringer No. 3?

Fig. 203 — Longitudinal Girders and Bulkheads 12′ Off Center Line

1. What girder plates extend from frame 155 to 171 on the second deck level?
2. What bulkhead plates are between the shelter deck and the promenade deck?
3. At what decks and between what frames is the longitudinal girder 10′ - 0″ off center line?
4. What type and size stiffeners are on plates "aab" and "aac"? Are the bulkhead stiffeners on inboard or outboard side?

Appendix I — Lines of a Ship

TERMS AND DEFINITIONS PERTAINING TO LINES OF A SHIP

Every shipfitter should be familiar with the technical names denoting ship lines, surfaces, and dimensions. Familiarity with these terms is essential in reading blueprints and in building and installing parts of a ship.

LINES DRAWING — A plan showing, in three views, the *moulded surface* of the vessel. (See Fig. 210).

MOULDED SURFACE — The inside surface of the skin, or plating, of a ship. The moulded surface has no thickness, and is fair and smooth.

Actually, when the ship has been built, the thickness of the plating will extend outside of the moulded surface. "Outside" strakes of plating do not touch the moulded surface if they have a liner against the shell frame. The *heel* of each shell frame is in this moulded surface (unless joggled). It should be remembered that this moulded surface is not an actual part of the ship. It is almost exactly the shape which a thin piece of sheet rubber would take if stretched tightly over the shell frames and main deck beams with no plating in place. (See Fig. 204).

BASE LINE — A straight horizontal line at or near the bottom of the *moulded surface* from which vertical heights are measured. Usually, the base line is the very lowest part of the moulded surface. In Fig. 205 is shown an exception.

WATER LINE — The intersection of the moulded surface with a horizontal plane at a given height above the base line. The six foot water line is exactly six feet higher than the base line.

These intersections are shown in the half breadth plan in the lines drawing. They should not be confused with the "load line" marked on the outside of a ship when built.

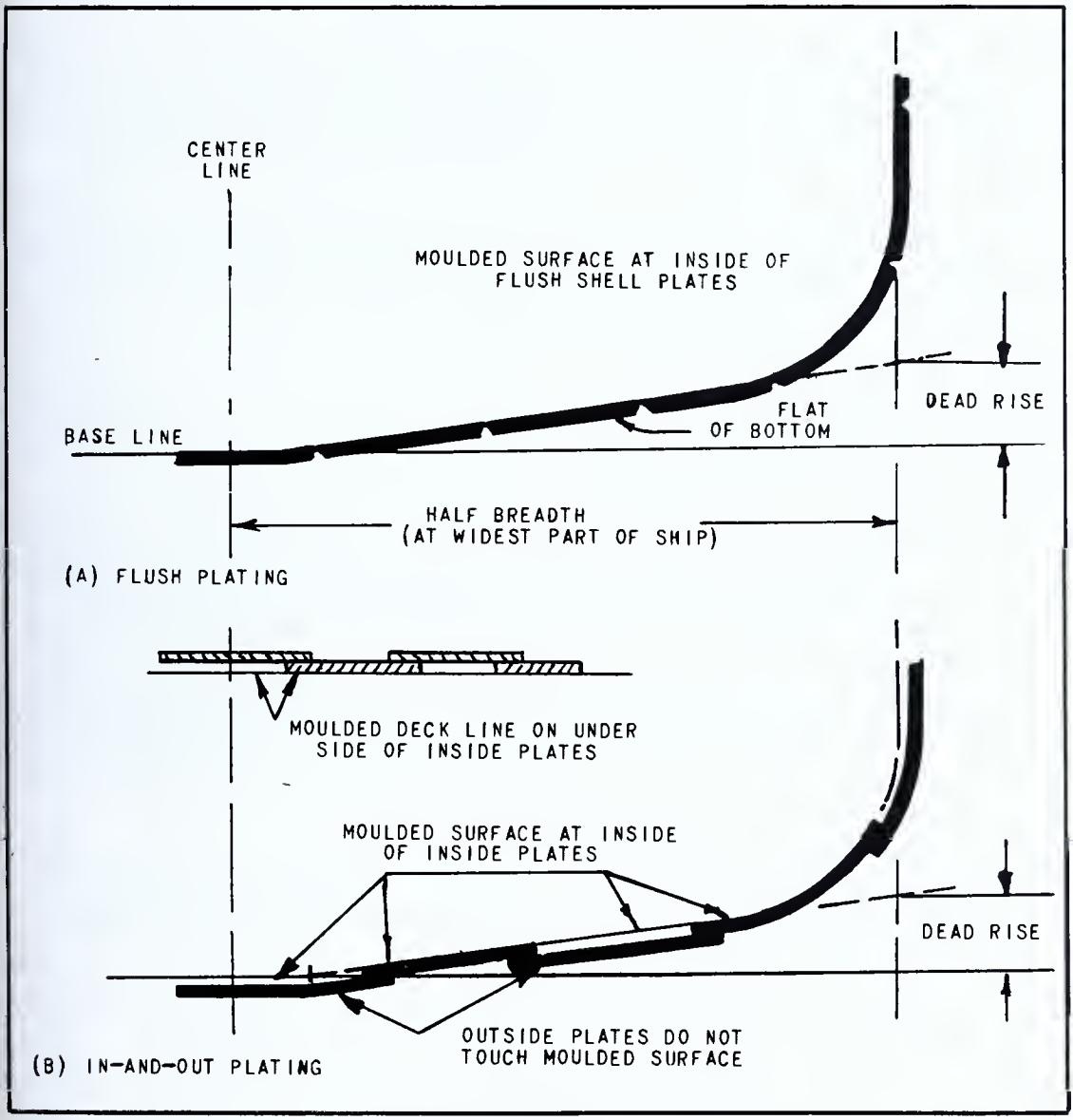

CENTER LINE
MOULDED SURFACE AT INSIDE OF FLUSH SHELL PLATES
DEAD RISE
FLAT OF BOTTOM
BASE LINE
HALF BREADTH (AT WIDEST PART OF SHIP)
(A) FLUSH PLATING
MOULDED DECK LINE ON UNDER SIDE OF INSIDE PLATES
MOULDED SURFACE AT INSIDE OF INSIDE PLATES
DEAD RISE
OUTSIDE PLATES DO NOT TOUCH MOULDED SURFACE
(B) IN-AND-OUT PLATING

FIG. 204 — *Moulded Surface*

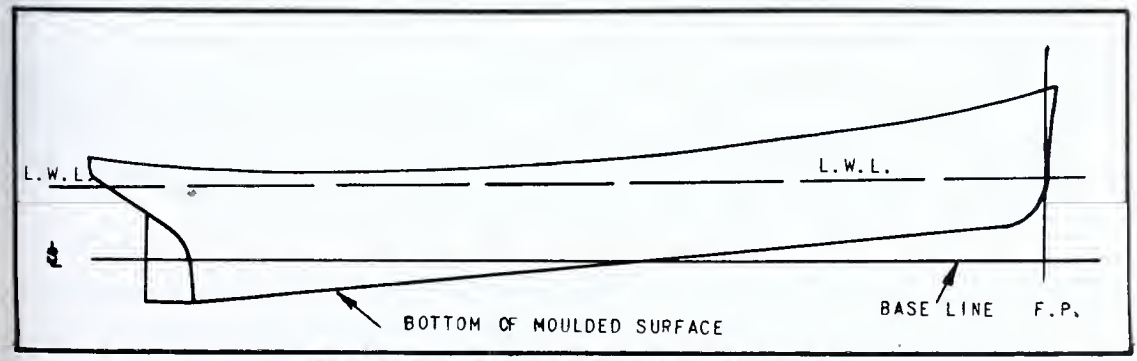


FIG. 205 — *Unusual Base Line Location*

Shipfitters use a water line merely as a height above the base line and in this sense water lines are marked on bulkheads, frames, and other members, for the purpose of properly setting and aligning the structure.

CENTER LINE — A straight line running from bow to stern, midway between the sides of the ship. All transverse horizontal dimensions are taken from the center line. The center line as applied to a transverse bulkhead is a vertical line in the middle of the ship.

BUTTOCK — The intersection of the moulded surface with a vertical plane at a given distance from the center line of the ship. Buttocks are shown in the profile in the lines drawing.

Shipfitters use a buttock merely as a distance from the center line. Thus, they have buttocks marked on bulkheads, decks, foundations, etc., for setting and alignment. The buttocks and the water lines which are marked on the steel members for regulating and setting are usually of some dimension expressed in even feet. That is, they would mark the 10′-0″ W. L. (water line) and the 24′-0″ Btk. (buttock) rather than a 10′-7″ W. L. or a 23′-6″ Btk.

FRAME LINE — The intersection of the moulded surface with a vertical plane perpendicular to the center line (transverse plane). Frame lines are shown in the body plan of the lines drawing. They get their name from the fact that shell "frames" or ribs usually are made to this shape and installed transversely in the ship. The lines drawing consists of three views; a half-breadth plan, a profile view, and a body plan. (See Fig. 210). These views each show only one side of the ship (usually, the port side), because all dimensions for the starboard are equal and to the opposite "hand"; that is, the ship is symmetrical about the center line.

PROFILE — A view looking at the moulded lines from starboard to port. The water lines and the frame lines are straight when observed from this direction. The deck line, or "sheer" curve shows up clearly in the profile, which for this reason is sometimes called the sheer plan.

BODY PLAN — A view showing the shapes of the frame lines. The body plan is made in two parts. The right-hand part is a view looking directly aft at the forward port side of moulded surface, while the left-hand part is a

view looking directly forward at the after half of the port side. This arrangement prevents the frame lines at the after end from obliterating or fouling the frame lines at the forward end. This view shows buttocks and water lines straight, while the frame lines appear in their true shape.

HALF-BREADTH or WATER LINE PLAN—A view looking down on the moulded surface. Here the frame lines and buttocks appear straight, while the water lines show their true shape. To save space, only the port side is shown.

LOAD WATER LINE (L. W. L.)—The water line at which the ship will float when loaded to its designed draft.

FORWARD PERPENDICULAR (F. P.)—A vertical line at the point where the load water line crosses the foremost part of the moulded surface.

AFTER PERPENDICULAR (A. P.)—A vertical line usually at the after end of the rudder post. If there is no rudder post, it usually is taken at the center of the rudder stock.

LENGTH BETWEEN PERPENDICULARS (L. B. P.)—The distance from the forward perpendicular to the after perpendicular. To the designers, this length is very important, since upon it largely depends the amount of power needed to drive the ship.

LENGTH OVER ALL (L. O. A.)—The total length of the ship from one end to the other, including bow and stern overhangs.

MIDSHIP SECTION—A transverse section exactly half way between the F. P. and the A. P. Almost invariably, this is the widest part of the ship.

PARALLEL MIDDLE BODY—The straight part at the center of the ship where the water lines and buttocks have no curvatures; that is, where all the fore and aft lines are parallel.

DEADRISE—The rise of bottom. It is the difference in height between the base line and the point where the straight line through the bottom flat surface intersects the vertical line through the side of the moulded surface at its widest point. (See A and B in Fig. 204; also, Fig. 206.)

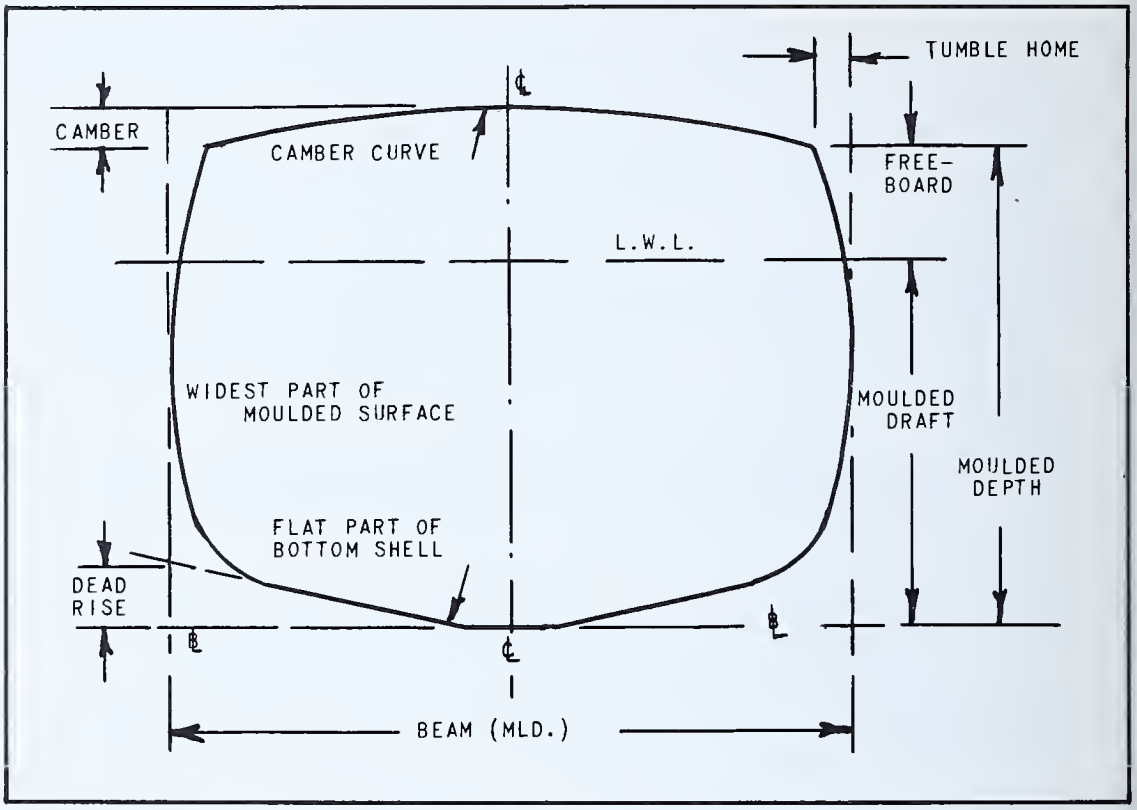


FIG. 206 — *Moulded Dimensions at Midship Section*

BEAM — The width of the ship (moulded surface) at the widest point. (See Fig. 206.)

DEPTH — The height of the ship at the midship section from the base line to the moulded line of the deck at side (underneath).

DRAFT (Moulded) — The height from the base line to the load water line.

FREEBOARD (Moulded) — The difference between the moulded depth and the moulded draft. (It is the height of the side of the vessel which is above the water when she floats at her load water line).

CAMBER — The curvature of the deck transversely. It is measured by the difference in height between the deck at center and the deck at side.

TUMBLE HOME — The amount the top of the side shell slopes back toward the center line between the point of widest breadth and the deck at side. (See Fig. 206.)

SHEER—The curvature of the deck at side as shown in the profile. The *amount of sheer forward* is the difference in height between the deck line (at side) amidships and the deck line at the forward end (see Fig. 207).

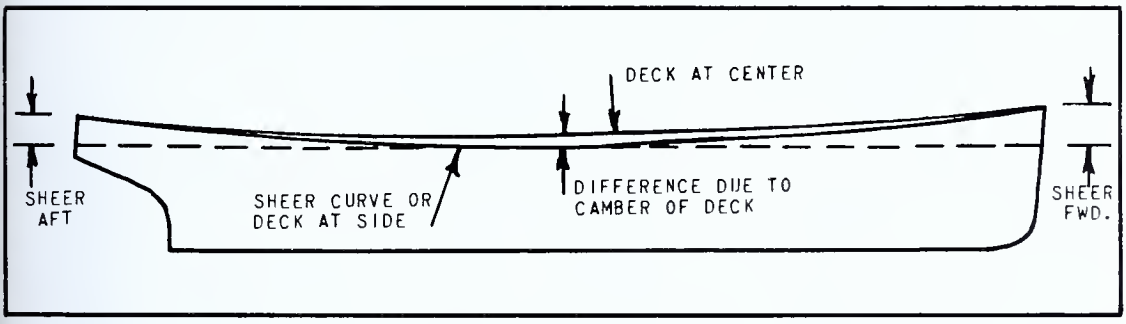


FIG. 207 — *Sheer Curve*

The amount of sheer aft is the difference in height between the deck (at side) amidships and the deck at the after end. The line of the deck at center, in the profile, is higher than the line of the deck at side, owing to the camber, or transverse curvature of the deck.

In Fig. 207 is illustrated the difference between the deck at the side and the deck at the center, owing to camber. The camber curve, as usually designed, is a circle of very large radius, but sometimes it is made as a series of straight lines, as in Fig. 208. The camber curve is the moulded line of the deck.

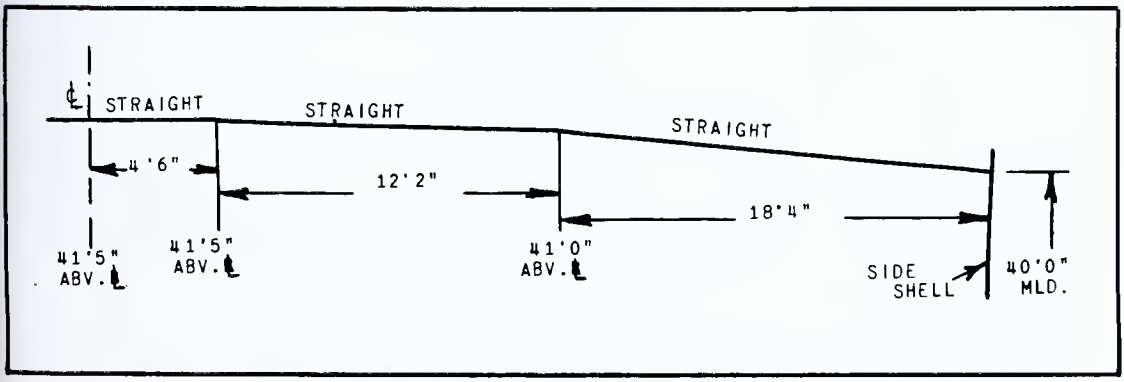
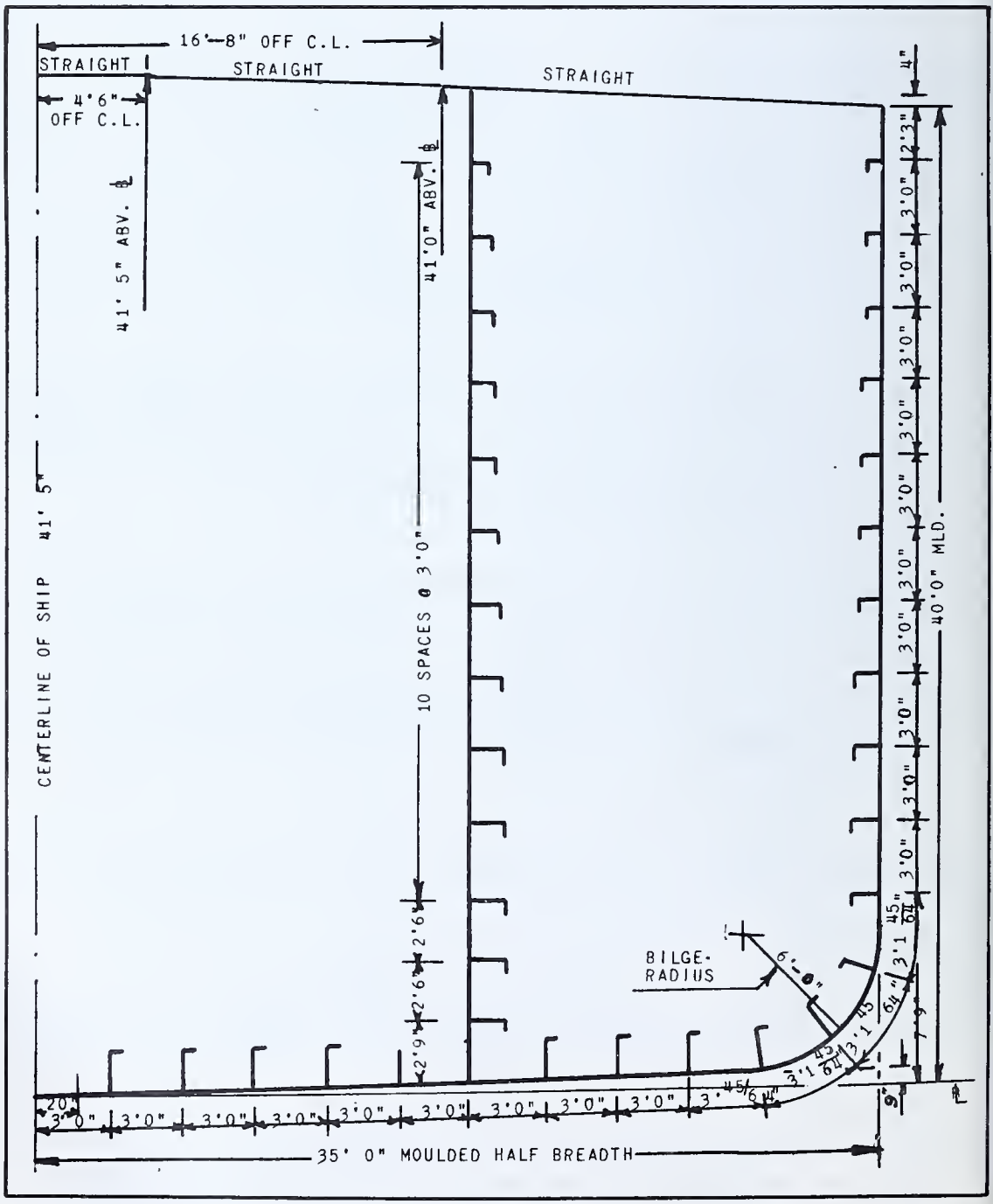


FIG. 208 — *Camber Curve — (Composed of Straight Lines)*

Midship Section and Offsets

The midship section of a ship, as stated before, is a transverse section taken halfway between the forward perpendicular and after perpendicular. Figure 209 shows the midship section of a type of oil tanker, giving the outline of the moulded surface at this section and also the spacing of the shell longitudinals and the longitudinal stiffeners.


16'-8" OFF C.L.
STRAIGHT
STRAIGHT
STRAIGHT
4'-6" OFF C.L.
41' 5" ABV. ℄
41'-0" ABV. ℄
CENTERLINE OF SHIP 41' 5"
10 SPACES @ 3'-0"
2'-6"
2'-6"
2'-9"
4"
2'-3"
3'-0"
40'-0" MLD.
BILGE-RADIUS
6'-0"
3'-1 45/64"
3'-1 45/64"
3'-1 45/64"
7'-9"
9'
3'-0"
3'-0"
3'-0"

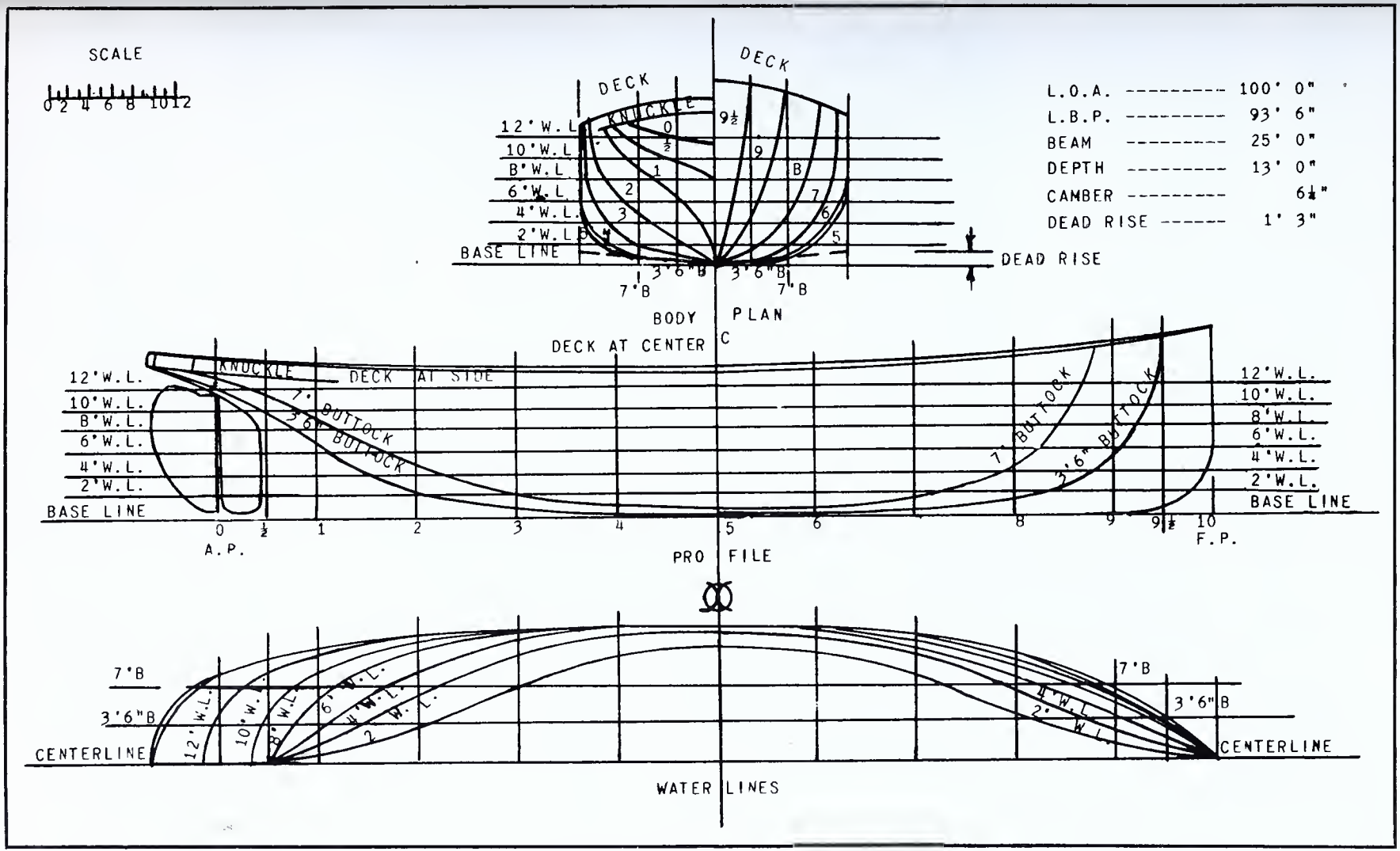


FIG. 210 — *"Lines Drawing"*

The camber of the deck is shown, as well as the deadrise and the bilge radius. This shape and spacing applies throughout the parallel middle body of the vessel (in this example, from frame 26 to frame 44).

As illustrated, the shell longitudinals are three feet apart except for one space at the top of the side shell and four spaces in the bilge. The longitudinal bulkhead stiffeners are three feet apart except for three spaces at the bottom. The deadrise is nine inches. The moulded beam is seventy feet. The moulded depth is forty feet. The bilge radius is six feet. The camber of the deck is 1′-5″ in straight lines. There is no tumble home.

The stiffeners (longitudinals) heel inboard on the bottom shell and upward on the side shell and longitudinal bulkhead. In Fig. 210 are given the midship section offsets for this tanker. Offsets are measurements of distance from the base line or from the center line to any point in the moulded surface. Half-breadths are measured transversely from the center line. Heights are measured vertically from the base line.

Appendix II

SHIPBUILDING TERMS, DEFINITIONS, AND ABBREVIATIONS

Terms and Definitions

A

ABAFT — Aft of; farther aft than.

ACCESS HOLES — Holes cut in ship's structure to permit entering or leaving various compartments.

ACCOMMODATION LADDER — A portable set of steps on a ship's side for the accommodation of people boarding from small boats or from a pier.

AFT — Toward, at, or near stern.

AFTER — Nearer stern.

AFTERMOST — Nearest the stern.

AFTER BODY — Hull form aft of the midship section.

AFTER PEAK — The compartment in the narrow part of the stern, aft of the last water-tight bulkhead.

AFTER PEAK BHD. — Watertight bulkhead farthest aft.

AFTER PERPENDICULAR — A vertical straight line at, or near, the after edge of rudder post.

AIR HAMMER — Hammer driven by compressed air for riveting, sometimes called an air gun or "gun".

AIR PORT — A circular opening or window through the ship's side, or deck house, for light or ventilation.

AMIDSHIPS — At or near the midship section of the ship.

ANCHOR — A heavy hook-shaped device for holding a ship at rest in water. The anchor grips the ocean bottom and is fastened to the ship by a chain.

ANGLE CLIP — A short piece of angle bar.

ANGLE COLLAR — A ring made of angle bar.

ANNEAL — To soften metal by heating and allowing it to cool slowly.

APERTURE — A recess in which the propeller is located.

APRON PLATE — Small plate on top of bulwark, at stem of vessel to stiffen bulwark.

ASSEMBLE — To fit together small parts, in making a large section, or part.

ATHWARTSHIP — Across the ship at right angles to the center-line.

AUXILIARIES — Machinery supplementary to main propulsive units.

AWNING DECK — Shade deck above another deck.

B

BALLAST — Any weight or weights (usually sea water) used to keep the ship from becoming "top heavy" or to change her trim.

BALLAST TANK — Watertight compartment to hold ballast.

BARNACLE — Small marine growth which attaches itself to a vessel's hull in large numbers, often greatly retarding her speed.

BATTENS — Long strips of wood used in the mold loft for fairing lines; also, wooden protective strips in cargo holds; see hatch battens.

BEAM — An athwartship member supporting a portion of a deck. Also, the width of the ship.

BEAM KNEE — (See Bracket).

BELOW — Below a deck or decks (corresponding to "down stairs").

BENDING ROLLS — Large machine used to give curvature to plates.

BENDING SLAB — Heavy cast iron perforated slabs arranged to form a large floor on which frames, etc., are bent.

BERTH — A place for a ship; a place to sleep; a bunk; also, a specified small section of the hull structure.

BETWEEN DECKS — The space between any two decks.

BEVEL — The angle between the flanges of a frame or other member. (When a greater than a right angle, open bevel; when less, closed). Also, to chamfer.

BILGE — Curved section between the botween the bottom and the side of a ship; the recess into which all water drains.

BILGE BLOCKS — Supporting blocks used under bilge for support during construction or dry-docking.

BILGE KEEL — A fore and aft member fitted to the outside of the shell plating along the bilge, to prevent excessive rolling of the ship.

BILGE PUMP — Pump for removing bilge water.

BILGE STRAKE — Course of plates at the bilge.

BILGE WATER — Water in ship due to leaks, sweat, etc.

BILGE WELL — A sump to which bilge water drains.

BINNACLE — A case, box, or stand containing a ship's compass, adjusting magnets, and a lamp for use at night.

BITT — A vertical post used in making fast lines; a bollard.

BITUMASTIC — An elastic cement used in place of paint to protect steel.

BOAT DECK — A deck on which life-boats are kept.

BODY PLAN — A drawing which shows frame lines in elevation.

BOILER — Container in which water is heated to form steam.

BOILER CHOCKS — Stay braces which prevent fore and aft movement of boilers.

BOILER FOUNDATION — A support for a boiler.

BOLLARD — A single tie post (see bitt).

BOOBY HATCH — A watertight covering over a deck opening, which is used for a stairway or ladder.

BOOM — A long, round, heavy spar, pivoted at one end, usually used for handling cargo, etc.

BOOM REST — A support for a boom when the boom is not in use.

BOOM STEP — A socket for end of boom.

BOSOM PIECE — A short piece of angle riveted over a butt joint of two angles, a butt strap for angle bars; a splice piece.

BOSS — The curved swelling portion of the ships hull around the propeller shaft.

BOSS FRAME — A hull frame which is bent for clearing propeller shaft tube.

BOSS PLATE — A shell plate covering the curved portion of hull where the propeller shaft passes outboard.

BOW — The forward end of a ship.

BRACKET — A triangular plate used to connect rigidly two or more parts, such as a deck beam to a frame, a frame to a margin plate, etc.

BRAZE — To heat and join by means of hard solder (spelter). This may be brass, bronze, or other alloys.

BREAKWATER — A braced guard plate which prevents solid water from sweeping the decks.

BREAST HOOK — A triangular-shaped plate extending horizontally across the bow behind the stem, stiffening the stringers and stem.

BRIDGE, NAVIGATING — A deck from which the ship is navigated.

BRIDGE DECK — A deck of the superstructure amidships.

BROW — A watershed over an airport; a small inclined runway to allow passage of trucks over hatch coaming, or through bulkhead door, etc.; sometimes portable.

BUILDING SLIP — A place where the ship is built; a shipway.

BULB ANGLE — An angle shape, which is reinforced at one toe.

BULB PLATE — A narrow plate reinforced on one edge.

BULB TEE — A Tee bar with toe of web reinforced.

BULKHEAD — A vertical partition corresponding to the wall of a room, extending either athwartships or fore and aft. A steel partition in a ship.

BULKHEAD SLUICE — A small opening in a watertight bulkhead which can be opened or closed from the deck above.

BULWARK — The ship's side above the weather deck.

BULL RIVETING — Driving rivets by squeezing them with a high powered air or hydraulic machine.

BUNKER — A compartment used for the stowage of coal or other fuel.

BUOYANCY — Ability to float; lifting power when immersed.

BUTT — The joint formed when two parts are placed edge to edge.

BUTTOCK — A distance from center line; an intersection of moulded surface with a vertical longitudinal plane.

BUTT STRAP — A small plate used to connect the two parts of a butt joint by overlapping each; a splice piece.

C

CAMBER — The athwartship rise or crown of a deck.

CANT FRAME — A frame which is not square to the keel line.

CAPSTAN — A revolving drum, with vertical axis, used for heaving in lines.

CARGO — The freight carried by a ship.

CARGO BATTENS — Strips of wood used to keep cargo away from the steel hull.

CARGO BOOM — A heavy boom used in handling cargo.

CARGO HATCH — A large opening in a deck which permits the loading of cargo into holds.

CARGO PORT — An opening in a ship's side used in loading and unloading cargo.

CASING — Bulkheads enclosing portion of vessel, as the boiler room casing. Also a covering for parts of machinery.

CAULK — To make a joint watertight.

CAULKER — One who caulks.

CEILING — Wood sheathing on the tank top, sides of ship, and bulkheads; used to protect cargo.

CENTER KEELSON — (See vertical keel).

CENTER LINE — The middle line of the ship, extending from stem to stern.

CHAFING PLATE — A bent plate used in minimizing chafing of ropes, as at hatches.

CHAIN LOCKER — A compartment in the forward portion of ship in which anchor chain is stowed.

CHAIN PIPE — A pipe for passage of anchor chain from deck to chain locker.

CHAIN RIVETING — Two or more rows of rivets spaces so that the rivets in one row are opposite those in an adjacent row.

CHAIN STOPPER — A device which prevents anchor chain from running out. It is moved into position after the anchor has been dropped.

CHAMFER — To cut off the sharp edge of a 90° corner. To trim to an acute angle.

CHART ROOM — A small room adjacent to the Pilot House in which charts and navigating instruments are located.

CHOCK — A heavy fitting through which ropes or hawsers may be led. A saddle or seat of wood or metal.

CHOCK - BOAT — A cradle or support for a lifeboat.

CHOCK - ROLLER — A chock with a sheave to prevent chafing of ropes.

CLEAT — A fitting having two arms or horns around which ropes may be made fast. A clip on the frames of a ship used to hold cargo battens in place.

CLINCHING PAN — A flat plate for clinching nails. (Used in the mold loft.)

COAMING — The vertical boundary of a hatch or skylight.

COFFERDAM — A narrow vacant space between two bulkheads. A double watertight bulkhead.

COLLAR — A flanged band or ring. A welded plate used to close a frame or beam penetration through plating.

COLLISION BULKHEAD — The watertight bulkhead nearest the bow of a ship; forepeak bulkhead.

COMPANIONWAY — A covered stairway leading downward from an open deck. A series of steps leading from the deck to a cabin or saloon below; also, the space occupied by these steps.

COMPARTMENT — A subdivision of space or room in a ship.

CORRUGATED — Having a series of wrinkles or grooves arranged so as to produce stiffness.

CORRUGATED BULKHEADS — Bulkheads with corrugated plating, eliminating the need for many welded stiffeners.

COUNTER — Overhang of the stern of a ship.

COUNTERSINK — To taper a hole for a flush rivet or bolt.

COWL — The hood-shaped top of a ventilator pipe.

CRADLE — A form on which bows, etc., are assembled. The support in which a ship rests during launching; a launching cradle.

D

DAVIT — A crane arm used in handling small boats, lifeboats, stores, gear, etc.

DEAD FLAT — A portion of a ship's side or bottom where the plating has no curvature; also, the midship portion of constant cross section. (The parallel middle body.)

DEAD RISE — The rise or upward slant of the bottom of a ship from the keel to the bilge.

DEADWEIGHT — The total weight of cargo, fuel, water, stores, passengers and crew, and their effects, which a ship can carry.

DECK — A part of a ship corresponding to the floor of a building.

DECK-HOUSE — A shelter built on deck.

DECLIVITY — Inclination of shipways to provide for launching.

DEEP TANK — A deep compartment usually extending from tank top to lower deck.

DERRICK — A device for hoisting heavy weights, cargo, etc.

DIE — A tool for forming a rivet head (applied to rivet dies).

DISPLACEMENT — The total weight of the ship when afloat, including everything on board, (equals weight of water displaced.) Usually expressed in long tons.

DOG — A small bent metal fitting used in closing doors, hatch covers, manhole covers, etc.; a bent bar of round iron used in holding shapes on bending slab; any small flat lug temporarily welded to structure as backing for a wedge.

DOLLY BAR — A heavy bar to hold against a rivet, to give backing when riveting.

DOUBLE BOTTOM — Compartments at bottom of ship between inner and outer bottoms, used for ballast tanks, water, fuel oil, etc.

DOUBLING PLATE — A plate fitted outside or inside of another to give extra strength or stiffness.

DRAG — The amount the stern end of the keel is below the bow end when the ship is afloat, but not on an even keel.

DRAFT — The vertical distance of the lowest point of the ship below the surface of the water, when afloat.

DRIFT PIN — A small tapered tool used in aligning holes in adjacent members.

DROP STRAKE — A strake discontinued near the bow or stern.

E

ERECTING — The process of hoisting into place and bolting the various parts of a ship's hull.

EVEN KEEL — A ship is said to be on an even keel when the keel is level or parallel to the surface of the water.

EXPANSION TRUNK — Raised portion of tank used on some oil tankers to allow for the expansion of oil when temperature changes.

EYE BOLT — Bolt whose head is in the form of a ring or eye.

F

FABRICATE — To make raw material ready for assembling or erection.

FACE PLATE — A narrow stiffening plate welded along the edge of any web frame or stiffener.

FAIRING or FAIRING UP — Correcting or fairing up a ship's lines or structural members; assembling the parts of ship so that they will be fair, that is, without kinks, bumps or waves; bringing the rivet holes into alignment.

FAIRLEAD — A fitting through or over which a rope, line, etc., may be led so as to change its direction without excessive friction.

FAIRWATER — Plate or casting used to preserve streamline flow past hull structure or propeller hub.

FATHOM — Six feet.

FATHOMETER — A device to measure the depth of water, by timing the travel of a sound wave from the ship to the ocean bottom and return.

FAYING SURFACE — The contact surface between two adjoining parts.

FENDER — A portable device to protect a ship when bumping a pier; sometimes made of wood, rope, etc.; permanently installed extension which protects the hull of a ship in docking.

FIDLEY — Casing top over boiler room.

FIDLEY HATCH — A hatch over boiler room.

FLAGSTAFF — Flagpole at stern of ship; ensign staff.

FLANGE — A part of a plate or shape at, or nearly at, right angles to main part; to bend over to form an angle.

FLARE — The sudden widening of the shell at top near the bow.

FLAT — A small partial deck (built level) without curvature.

FLOOR — The lower portion of a transverse frame, usually a vertical plate, extending from center line to bilge, and from inner to outer bottom.

FORE AND AFT — In line with the length of the ship, longitudinally.

FORE AND AFT GANGWAY — A walkway between deckhouses at or near center line of ship.

FOREBODY — A hull form forward of the midship section.

FORECASTLE — The forward upper portion of the hull, sometimes used for the crew's quarters.

FOREFOOT — The part of the keel which curves and rises to meet the stem.

FOREPEAK — The large compartment or tank, at the bow in the lower part of the ship.

FOREPEAK BULKHEAD — Collision bulkhead; bulkhead nearest bow.

FORGING — Steel worked to special shape by hammering while red hot.

FORWARD — Near, at, or toward, the bow of the ship.

FORWARD PERPENDICULAR — A vertical line through the intersection of the stem with the load water line.

FOUNDATIONS — Supports for boilers, engines, and auxiliary machinery.

FOUNDATIONS, AUXILIARY — Supports for small machinery, such as winches, condensers, heaters, etc.

FRAMES — Ribs forming the skeleton of a ship.

FRAMES — CONTINUOUS — Frames combining side frames and floors.

FRAME, SIDE — Frame inside a ship, above and connecting to margin plate or floor plates.

FRAME SPACING — The fore and aft distance between adjacent frames.

FRAME, WEB — A heavy side or continuous frame, made with web plate for extra stiffness.

FREEBOARD — The vertical distance from the upper watertight deck to water line, when the ship is fully loaded.

FREEBOARD MARK — (See Plimsoll mark.)

FREEING PORT — Hole through bulwark which provides ready drainage of water from deck.

FUNNEL — A smokestack of a vessel.

FURNACE — A heater or large forge for heating plates or shapes for bending; to bend by heating in furnace.

G

GALLEY — A cook room or kitchen.

GALLEY DRESSER — A cook's work table.

GALVANIZING — Coating metal parts with zinc for protection from rust.

GANGWAY — A passageway, a ladder, or other means of boarding a ship.

GARBOARD STRAKE — The course of plates next to the keel of a ship.

GASKET — Packing of canvas composition, or other material, used in making a tight joint.

GIRDER — Fore and aft stiffening member for deck or bottom shell.

GIRTH — Any expanded length.

GRAB RODS — Bent rods welded to bulkheads or ship's side to form a ladder.

GRATING — Light platform or walkway built up of metal bars, used for access to machinery.

GROMMET — A soft ring used under a nut or bolthead to maintain water tightness.

GROSS TONNAGE — A figure obtained by dividing the total volume of the ship, in cubic feet, by 100.

GROUND WAYS — Timbers secured to the ground, under the hull on each side of the keel, on which a ship is launched.

GUDGEONS — Bosses on stern post drilled for pins (pintles) on which rudder swings.

GUNWALE — The junction of deck and shell at top of sheer strake.

GUNWALE BAR — Angle iron which connects stringer plate and shell plates. (Riveted work.)

GYRO - COMPASS — A mechanical compass operated by means of a gyroscope. This compass indicates true north rather than magnetic north.

GYRO - REPEATER — An apparatus to show the reading of the gyro compass at a distance from the main gyroscope equipment.

H

HATCH — An opening in a deck for passage of cargo, etc.

HATCH BATTENS — Flat bars which are wedged against hatch coamings to secure tarpaulins.

HATCH BEAM — A portable beam used to support wooden hatch covers.

HAWSE PIPE — Casting, or castings, through deck and side of ship at bow for passage of anchor chain.

HAWSER — A large rope used in towing or mooring.

HEELING — The inclination of a vessel to one side.

HOGGING — Straining of the ship which tends to make the bow and stern lower than the middle portion.

HOLD — The inside of a hull; cargo space.

HOLD BEAMS — Structural members placed in a hold, similar to deck beams, but having no plating or planking on them.

HOLDER - ON — One who "backs up" or "holds on" the head of a rivet while the point is being "driven", or upset.

HORN — To line or square up; also, part of a cleat.

HULL — The body of a ship, including shell plating, framing, decks, bulkheads.

I

I - BEAM — A structural shape with cross section resembling the letter I.

INBOARD — Inside of the ship; toward or nearer the center line.

INBOARD PROFILE — A drawing of the longitudinal section at center line of ship.

INNER BOTTOM — Plating forming the upper surface of the double bottom. Also called tank top.

INNER SHELL — A plated surface or "shell" inside the outer shell plating, used as additional protection in case of collision or other accidents. The space between the inner and outer shells is often used as a storage space for liquid ballast or cargo.

INSERTED PACKING — Red lead-soaked canvas strips placed between connections that cannot be caulked successfully; stop waters.

INTERCOSTAL — Made in separate parts; between frames, beams, etc.; the opposite of continuous. (Floors are continuous; longitudinal girders are intercostal in most cargo vessels.)

ISHERWOOD SYSTEM — A system of building ships in which the main framing is longitudinal or fore and aft, instead of transverse as in ordinary ships.

J

JACK STAFF — A flagstaff at the bow of a ship.

JOGGLE — An abrupt bend or offset in a plate, bar, or frame to eliminate the use of liners.

K

KEEL — The principal fore and aft member of a ship's frame. The keel runs along the bottom, connecting the stem and stern, and to it are attached the frames of the ship.

KEEL-BLOCKS — Heavy blocks which support the keel of the ship during construction.

KEEL, FLAT — The bottom shell strake on center line of ship.

KEELSON, SIDE — Fore and aft member placed on either side of, and similar to, the vertical keel.

KEEL, VERTICAL — Vertical plate used as reinforcement for keel, often called center-keelson.

KING POST — A stub mast, outward from center line, used to carry cargo booms; kingposts often serve as ventilators.

KNOT — A tie in a line. A nautical mile. (About one and one-seventh statute miles.)

KNUCKLE — A sharp bend in a plate or shape.

KNUCKLE PLATE — A plate bent to form a knuckle.

L

LADDER — Inclined steps, used aboard ship in place of "stairs".

LAP — A joint in which one part overlaps the other, thus avoiding the use of a butt strap; also, the amount of overlap.

LAUNCHING — The operation of placing a hull in the water by allowing it to slide down on greased skids, called launching ways.

LAYING OUT — Marking plates or shapes, for shearing, punching, etc.

LAZARETTE — Ship's storeroom between decks.

LENGTH BETWEEN PERPENDICULARS — The length of a ship measured from the forward perpendicular to the after perpendicular.

LENGTH OVER ALL — The length of a ship measured from the extreme forward end to the aftermost point of the stern.

LIFT — To make a template from measurements taken from the job.

LIGHTENING HOLE — A hole cut in any member to reduce its weight.

LIMBER HOLE — A small hole cut in a plate near the bottom to permit the passage of water.

LINER — A flat or tapered strip of steel placed under a plate or shape to bring the member in line with another which it overlaps. A filler.

LINES — The form of a ship as represented by its moulded surface.

LIST — To lean over to one side.

LOAD WATER LINE — Line of surface of water on a ship when loaded to designed draft.

LOFTSMAN — A workman in the mold loft, who lays down ship lines and makes templates.

LONGITUDINAL — A shell, deck, or bulkhead stiffener running fore and aft.

LUG PAD — A projection on deck with hole for fastening a block for a lead.

M

MAGNETIC COMPASS — A device which indicates the direction of magnetic north by means of a magnetized needle (or needles) which is attracted towards the Earth's magnetic pole. Magnetic north is not to be confused with true or geographical north.

MAIN DECK — Usually the deck immediately below the shelter or weather deck.

MANHOLE — A hole cut in a bulkhead, tank top, etc., to allow the passage of a man.

MARGIN PLATE — The outboard row of plates of the inner bottom, connecting to the shell plating at the bilge.

MARKER — A brass pipe dipped into paint which is used in marking rivet holes.

MARLINSPIKE — A pointed tapering tool which is used in separating strands of rope or cable in splicing.

MAST — A large long spar, placed nearly vertical on the center line of a ship.

MESS ROOM — A dining room for officers or crew.

MIDSHIP — At or near the middle point of a ship's length.

MIDSHIP SECTION — A cross section through the ship, midway between the forward and after perpendiculars.

MOLD LOFT — A shed or building with large, smooth floor on which the lines of a ship can be drawn to full scale.

MOORING — Securing a ship in position by several lines or cables, so that she cannot move or swing; anchoring.

MOORING PIPE — A casting which prevents chafing of mooring lines passing through bulwark plating.

MOULD or MOLD — A light pattern of a part of a ship; usually made of thin wood or paper. Also called a template.

N

NET TONNAGE — A figure obtained by making deduction from the gross tonnage for space not available for carrying cargo.

O

OAKUM — Untwisted fibres of old rope treated with a composition of resin and pitch, used to fill seams of wooden decks.

OFFSET — To move out of line or position.

OFFSETS — A table of moulded dimensions for water lines, decks, etc.

OIL TIGHT — Sealed by welding or caulking to prevent oil leakage. (Closer rivet spacing is required than for watertight work.)

OLD MAN — A rig for holding a drilling machine.

ON BOARD — On or in the ship.

ON DECK — On the upper deck; in the open air.

OUTBOARD — Away from the center line, towards the side of a ship.

OVERBOARD — Outside; over the side of a ship; into the water.

OVERHANG — That portion of the hull which is over and unsupported by the water.

OXTER PLATE — Bent shell plate which fits around upper part of stern post; also called tuck plate.

P

PACKING — Material which is placed between plates or shapes to make them watertight; wooden blocks and wedges which support a ship on sliding ways; spacers.

PAD EYE — An eye located on deck which is used for fastening cables; on the hull, an attachment for hanging a block and fall for lifting propeller or rudder.

PALM — Flattened top portion of rudder stock (for bolted connection). Also, a flat surface at the end of a strut or stanchion.

PANTING — An in-and-out movement of plating; to pulsate or throb. Panting may be caused by the lift and fall of a ship in a seaway, or by engine vibration.

PEAK — A narrow compartment at either end of a vessel.

PELORUS — An instrument used for taking directional bearings or sights, similar to a compass but without magnetic needles.

PILLAR — A vertical member or column which provides support to a deck girder. (Also termed a stanchion.)

PILOT HOUSE — An enclosed place in which the main steering wheel, controls, engine room telegraph, etc., are located. A wheel house.

PINTLE — A pin on which a rudder hinges.

PITCH — Spacing; as of rivets or gear teeth.

PLANKING — Wood covering for decks, etc.

PLATING — The plates of a hull, a deck, a bulkhead, etc.

PLIMSOLL MARK — A mark placed on the ship's side to indicate maximum allowable draft.

PONTOON HATCH COVER — A steel box-shaped member sometimes used in place of hatch beams to close in a cargo hatch.

POOP — The after, upper portion of the hull, often containing the steering gear.

POOP DECK — The first deck above the shelter deck at after end of a vessel.

PORT — A harbor; an opening in the side of a ship. The left hand side of a ship (looking toward the bow.)

PORTHOLE — A circular opening in the ship's side (see airport).

PROFILE — A side elevation of a ship's form.

PROPELLER — A rotating device which drives a ship through the water.

PROPELLER POST — The forward post of stern frame, which is bored for propeller shaft.

PROPELLER SHAFT — Rotating bar by means of which the engine turns the propeller.

Q

QUARTERS — Living or sleeping rooms.

R

RABBET — A depression or offset designed to take some other adjoining part; as for example, the rabbet in the stem to take the shell plating.

RAIL — The upper rounded edge of the bulwarks.

RAKE — Slope aft of a mast, kingpost or stack.

REAMING — Enlarging a rivet hole by means of a revolving, cylindrical, slightly tapered tool with cutting edges running along its sides.

REVERSE FRAME — An angle bar or other shape riveted to the inner edge of a transverse frame as reinforcement.

RIBBAND — A fore and aft wooden strip or heavy batten which is used to temporarily align the transverse frames after erection.

RIGGING — Ropes, wire ropes, lashings, masts, booms, etc.; also, the handling and placing on board the ship of heavy weights and machinery.

RIVET — A short round metal connection used to fasten two or more members together by clinching after being heated red hot.

ROLL — To impart curvature to a plate. Also, the motion of the ship from side to side, alternately raising and lowering each side of the deck.

ROLLER CHOCK — (See Chock Roller.)

ROSE BOX — A screen or strainer placed around the end of a bilge suction pipe.

RUDDER — A flat piece or structure of wood or metal attached upright to the sternpost (or in single screw-vessels, to the rudder post) of a vessel by hinges, or pintles and gudgeons, so that it can be turned, as by a tiller, causing the vessel's head to turn in the same direction, because of the resistance offered to the water by the rudder.

RUDDER POST — After post of stern frame to which the rudder is hung. (Also called stern post.)

RUDDER STOCK — The shank of a rudder which extends through shell upward to the steering engine.

RUDDER STOP — Lug to limit the swing of the rudder.

S

SAGGING — Straining of the ship which tends to make the middle portion lower than the bow and stern.

SAMSON POST — A heavy vertical post which supports cargo booms; kingpost.

SCANTLINGS — The dimensions of various shapes.

SCARF — To thin out or taper a corner or edge of a plate or shape to make a lap. A joint in a stem, bar keel or stern frame.

SCREEN BULKHEAD — A bulkhead, usually placed between the engine room and boiler room, which is fire proof, dust proof, and gas tight.

SCUPPER — A deck drain.

SCUPPER PIPE — A pipe which drains water from scuppers through the side of a ship.

SCUTTLE — A very small hatch; a manhole.

SCUTTLE BUTT — A container for drinking water.

SEA CHEST — A compartment through which sea water is admitted or discharged.

SEAM — A riveted or welded plate edge connection. A riveted seam overlaps; a welded seam may or may not overlap.

SET — Metal mold or template for use on bending slab.

SET IRON — A bar of soft iron used on bending slab to give shape of frames.

SHAFT ALLEY — A casing (large enough in which to walk), covering the propeller shaft and extending from engine room to after peak.

SHAFT TUNNEL — (See Shaft Alley.)

SHAPE — A bar of constant cross section, such as a channel, T-bar, angle bar, etc. Also, to impart curvature to a plate or other member.

SHEAR LINE — A line at which a shearing cut is to be made.

SHEARS — A large machine for cutting plates and shapes.

SHEER — Curvature of deck in a fore and aft direction as seen in profile. (See Part I — "Lines of a Ship".)

SHEER PLAN — A side elevation of ship's form; a profile.

SHEER STRAKE — The top full course of side shell plating.

SHELL EXPANSION — A plan showing details of all shell plating and shell longitudinals.

(Longitudinals would appear only on tankers.)

SHELL LANDINGS — Points on the frames where the edges of shell plates are to be located.

SHELL PLATING — The plates forming the outer skin of the hull.

SHELTER DECK — A continuous superstructure deck above the freeboard deck.

SHORE — A temporary brace or prop.

SIGHT EDGES — Visible edges of plating (outside shell and above decks).

SKYLIGHT — An opening in a deck to give air and light to the compartment below it.

SLIDING WAY — That part of launching way which moves with the ship.

SLOP CHUTE — Chute for dumping garbage overboard.

SOUNDING PIPE — Vertical pipe in oil or water tank used in measuring depth of liquid in tank.

SPAR — Long, round member such as mast or boom; part of rigging.

STABILITY — The tendency of a ship to remain upright.

STAGING — Planks or scaffolding on which to stand when working on sides or under decks.

STANCHION — A pillar or upright post.

STAPLING — Collars, forged from angle bars, which fit around continuous members passing through bulkheads or decks, to insure water tightness.

STARBOARD — The right hand side of a ship, looking forward.

STAY — A guy line.

STEALER — A plate extending into an adjoining strake as at the end of a drop strake.

STEERING GEAR — Apparatus for controlling the rudder.

STEM — Forging, casting, or plating forming extreme bow of ship and extending from keel to forecastle deck.

STEP — To set in place (as applied to a mast); also, a socket for the end of a mast; a support for the fixed or "hinged" end of a boom.

STERN — The after or back end of a vessel.

STERN FRAME — A large casting or forging attached to the after end of hull to form the ship's stern. It includes rudder post, propeller post, and aperture for the propeller.

STERN TUBE — A long bushing or bearing through the stern to support the end of a propeller shaft.

STIFFENER — An angle bar, T-bar, channel, etc., used to stiffen plating of a bulkhead or other member.

STOOL — A support for a propeller shaft bearing in the shaft alley. A foundation, etc.

STOP WATER — Canvas and red lead, or other material, fitted between two metal parts to make a watertight joint.

STOWAGE — A support or fastening for any gear, as, anchor or boat stowage.

STRAKE — A fore and aft course, or row, of shell or other plating.

STRINGER — A fore and aft member used to give longitudinal strength. Depending on location, these are called hold stringers, bilge stringers, side stringers, etc.

STRINGER, DECK — The strake of deck plating which contacts the shell.

STRINGER PLATE — A deck plate at the outboard edge of deck connected to the shell of a ship with an angle or a welded joint.

STRONG BACK — A supporting girder for a hatch cover; a rig used in straightening bent plates; a bar for locking cargo ports.

STRUT — A support for a propeller tail shaft (used on ships with more than one propeller).

SUPER-STRUCTURE — Deck houses, etc., which are located above shelter deck.

SWASH PLATE — A baffle plate in a tank which prevents excessive surging of a liquid.

T

TAIL SHAFT — A short section of a propeller shaft extending through the stern tube and carrying the propeller.

TANK TOP — The plating over the double bottom.

TARPAULIN — A waterproof canvas covering for a hatch or other purpose.

TEE-BAR — A structural shape with cross section resembling the letter T.

TELEGRAPH — A mechanically- or electrically-operated means of signalling from bridge to engine room, etc.

TEMPLATE — A mold or pattern.

THRUST BEARING — A bearing or block to resist end thrust. A bearing on propeller line shaft which relieves the engine from the driving force of the propeller.

THWART — A seat in a lifeboat.

TILLER — An arm, attached to rudder head, which operates the rudder.

TRANSOM — The main frame at the rudder stock (cant frames usually radiate from the transom frame).

TRANSVERSE — Athwartships; at right angles to the keel.

TRANSVERSE FRAMES — Athwartship members forming the ship's "ribs".

TRIM — To shift ballast; to cause a ship to change its position in the water; drag.

TRUNK — A small casing passing through a deck, such as is used for ladders or ventilation.

TUMBLE HOME — An inboard slant of a ship's side above the bilge.

U

UPTAKE — Connection between boilers and smokestack.

V

VERTICAL KEEL — A row of vertical plates extending along the center of the flat plate keel. It sometimes is called the center keelson.

VOICE TUBE — A large speaking tube.

W

WATER LINE — Any one of certain lines of a ship parallel with (and at various heights above) the base line. In half-breadth plans the water lines are smooth curves showing the shape of the ship; in profile plans they are projected as straight lines.

WATERTIGHT — So riveted, caulked, or welded as to prevent the passage of water.

WATERWAY — A narrow passage along the edge of a deck for drainage. A gutter.

WAYS — Timbers, etc., on which a ship is built or launched. (See Launching.)

WEATHER DECK — A deck exposed to the weather.

WEB — The vertical portion of a beam, the thwartship portion of a frame, etc.

WEB FRAME — A frame with a deep web.

WELDING — Fusing together two or more members with electric arc or by other means.

WELL — A cofferdam or a sump in the double bottom.

WHEEL — Nickname for propeller; steering gear control.

WINCH — A small hoisting engine; used in pulling lines, or in handling cargo.

WINDLASS — A machine used to hoist the anchors by winding in the anchor chain.

WIND SCOOP — A device used to divert air into a compartment of a ship.

Z

ZEE-BAR — A structural shape with a cross section resembling the letter Z.

ZIG-ZAG RIVETING — Two or more rows of rivets spaced so that the rivets of one row are offset.

Abbreviations Used by Shipfitters

AE — After end (rear or stern)
ALT — Alteration
AMM — Ammunition
A.P. — After peak
A.P. — After perpendicular
AUX — Auxiliary
B.A. — Bulb angle
BET — Between
BEV — Bevel
BHD — Bulkhead
BRKT — Bracket
B — Base line
B.M. — Bolted manhole cover plate
B/M — Bill of material
BOT — Bottom
BTK — Buttock
C — Channel or channels
CL or C — Center line
COFF — Cofferdam
CSK — Countersink holes
CSK-OS — Countersink other side
COMP'T — Compartment
COND — Condenser
CONN — Connection
C. to C. — Center to center
C. R. C. — Closed roller chock
C. T. C. — Closed towing chock
CTRS — Centers
C. V. K. — Center vertical keel
D or DIA — Diameter
DBLR — Doubler
DIM — Dimension
D(or DK — Deck
DN or DWN — Down
DR — Door
ELEV — Elevation
E. M. — Expanded metal
E. R. — Engine room
EXH — Exhaust
EXP — Expanded
f — Finish
F.B. — Flat bar
F.D. BLOWER — Forced draft blower
FDK — Forecastle deck
FE — Forward end (front or bow)
F.K. — Flat keel
FLG— Flange
F.O. — Fuel oil
FOCS'LE — Forecastle
FOR'D or FWD — Forward
FND — Foundation
F.P. — Forepeak or forward perpendicular
F.P. — Flanged plate
FR — Frame
F.W. — Fresh water
GALV — Galvanize
GEN — Generator
GIR —Girder
H — Hull or "H"-Beam
HLS — Holes
H.P. — High pressure or horse power
H.R. — Half round
I — "I"-beam
IB — Inboard
I.D. — Inside diameter
INV — Inverted
KP — Kingpost
L — Angle, locker, length, or longitudinal
L.B.P. — Length between perpendiculars
LBS or # — Pounds
L.O.A. — Length over all
L or LONG — Longitudinal
L.P. — Low pressure
LUB OIL — Lubricating oil
L.W.L. — Load waterline
MAX — Maximum
MIN — Minimum
M.L. — Moulded line
MLD — Moulded
M.P. — Mooring pipe
N — Near
NO-CSK — No countersink

NO or # — Number
N.W.T. — Non-water tight
OB — Outboard
O.C. — Open chock
O.D. — Outside diameter
OPP — Opposite side
O.S. — Other side
O.T.— Oil tight
O.T.H. — Oil tight hatch
P — Port
P.C. — Pitch circle
PDK — Poop deck
PLT or P — Plate
PLTG — Plating
PM — Pitch mark, check mark, or spot
R or RAD — Radius
R.C. — Roller chock
REQ — Required
RIV — Rivet
R.O.T.M.H. — Raised oil tight manhole
R.P.M. — Revolutions per minute
S or STBD — Starboard
SC.DR. — Screen door
SDK — Shelter deck
S — Shear or seam
S. N. W. T. — Steel non-watertight
S.P. — Shell plate
S.R. — State room
STIFF — Stiffener
STR — Stringer
S.W.T. — Steel watertight
T — "T"-bar
T.C. — Towing chock
TEMP — Template
THD — Thread
THK — Thick
TRANS — Transverse
T. S. — This side
T.S.U. — This side up
T.T. — Tank top
U — Up
UDK — Upper deck
V — Vent
V.K. — Vertical keel
V.L. — Vertical ladder
W — Weld
W.C. — Water closet
WL — Water line
W.R. — Wardrobe or washroom
W.T. — Watertight
W.T.M.H. — Water tight manhole
Z — "Z" bar

O — Midship section — universal as exchangeable material

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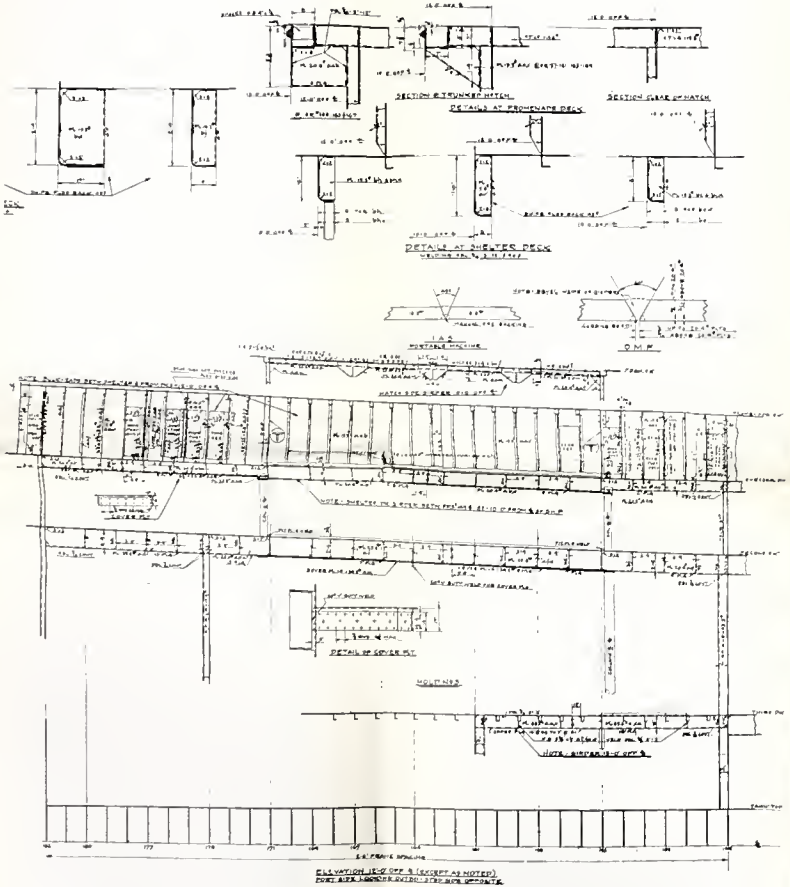
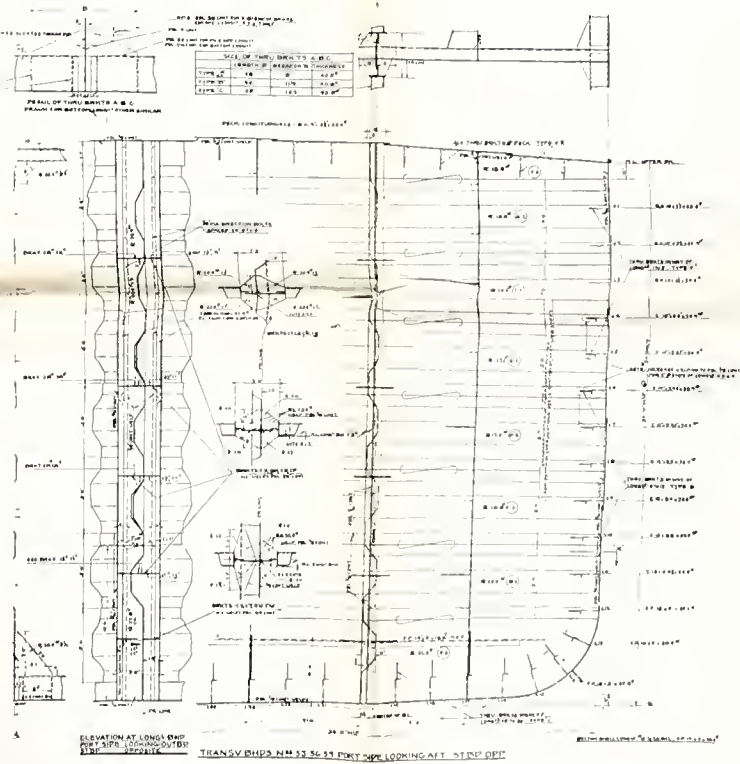


SHIP ERECTION FIG. 203

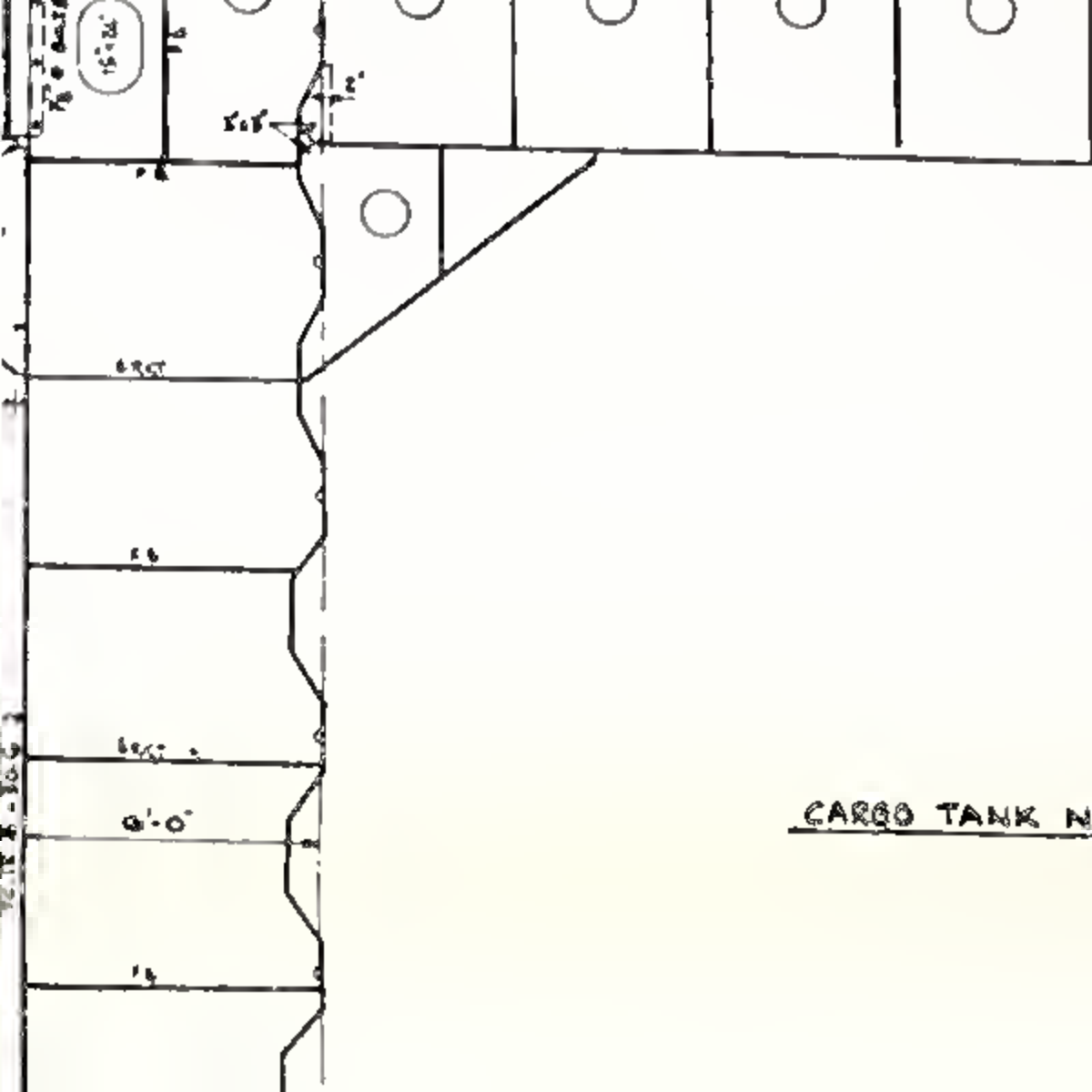
BLUEPRINT READING FOR SHIP ERECTORS

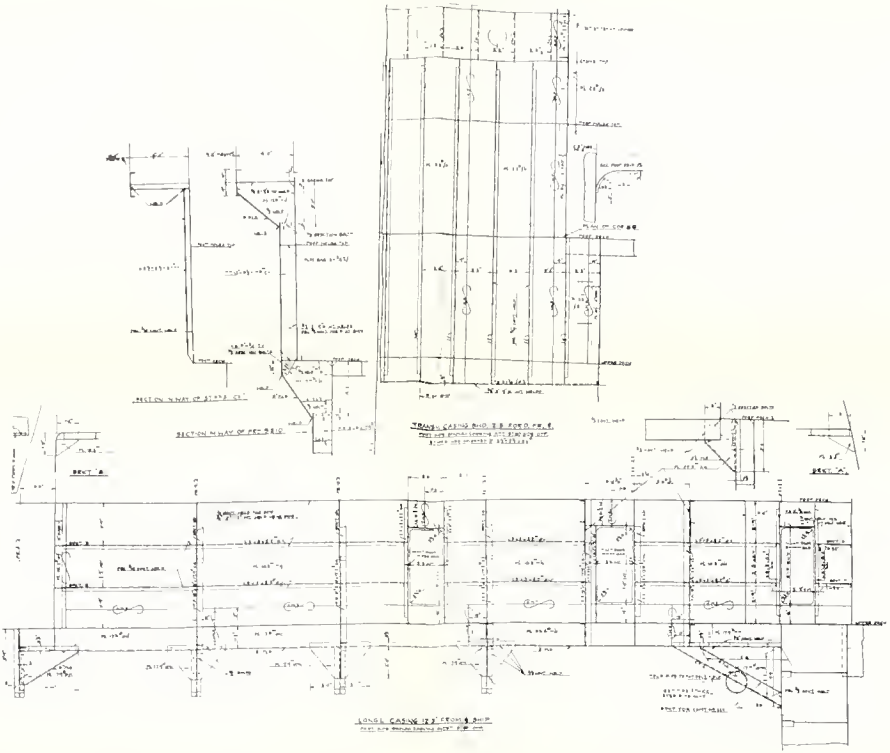
Supplement to Bulletin 349—"Ship Erection"

Published by
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC INSTRUCTION
Harrisburg

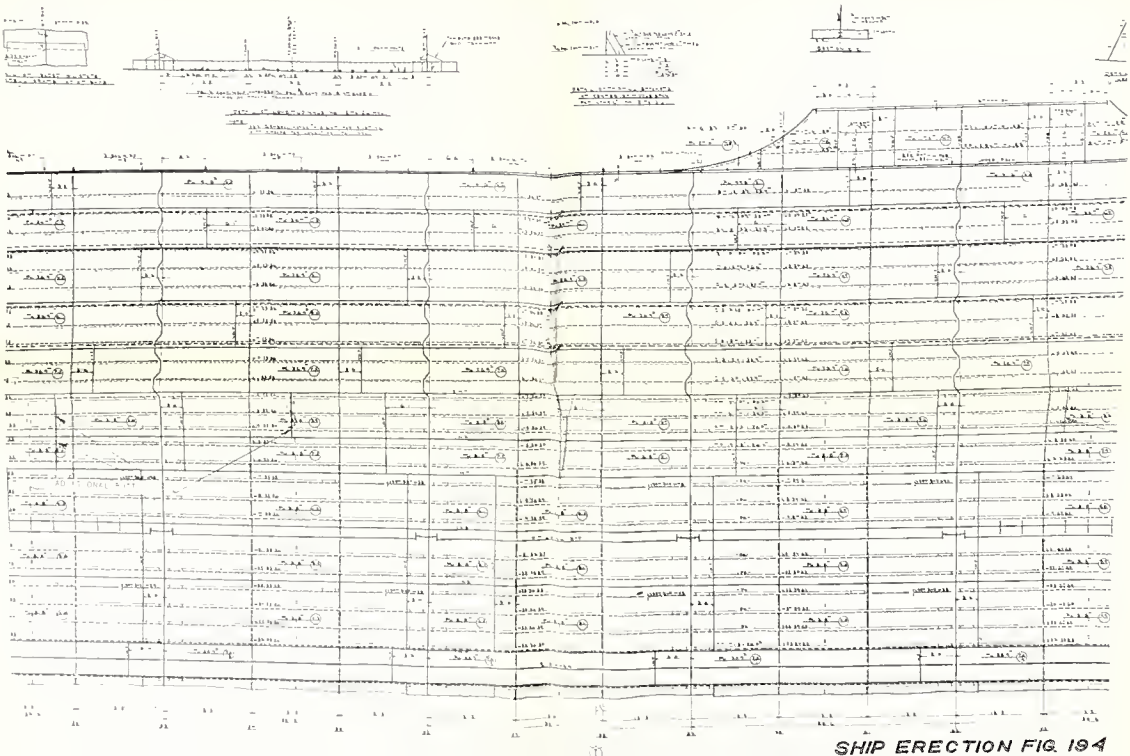


SHIP ERECTION FIG. 192

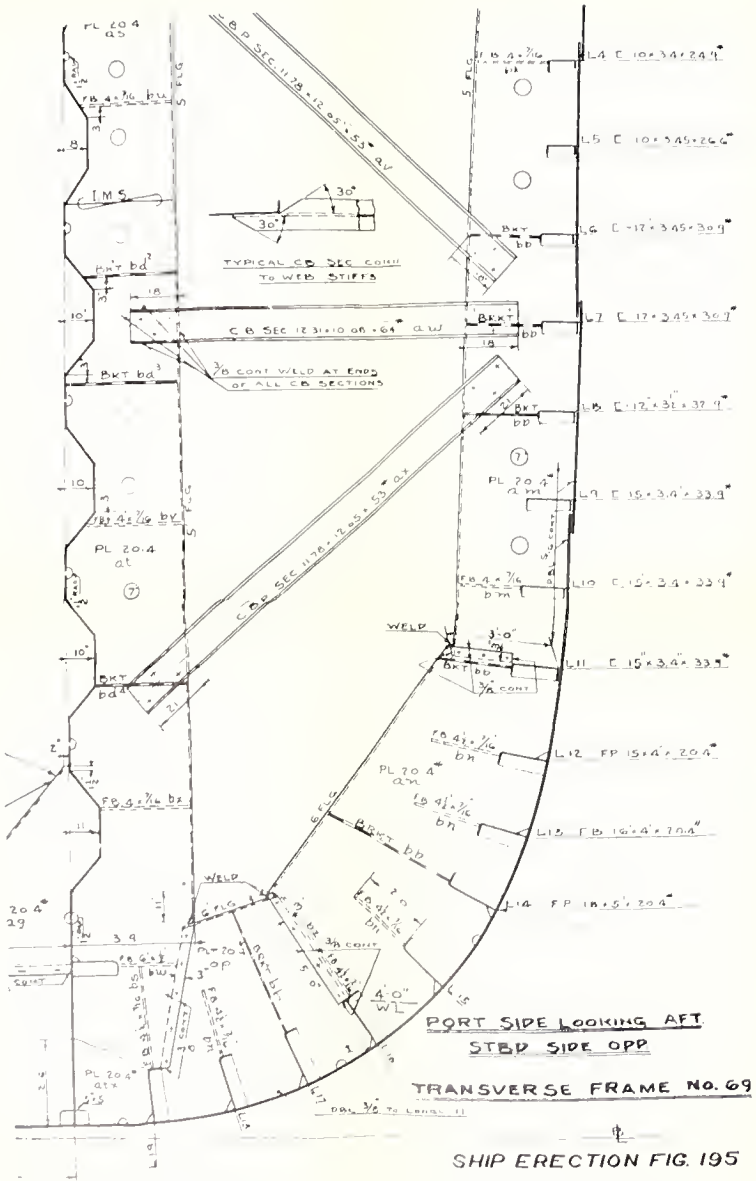

CARGO TANK N



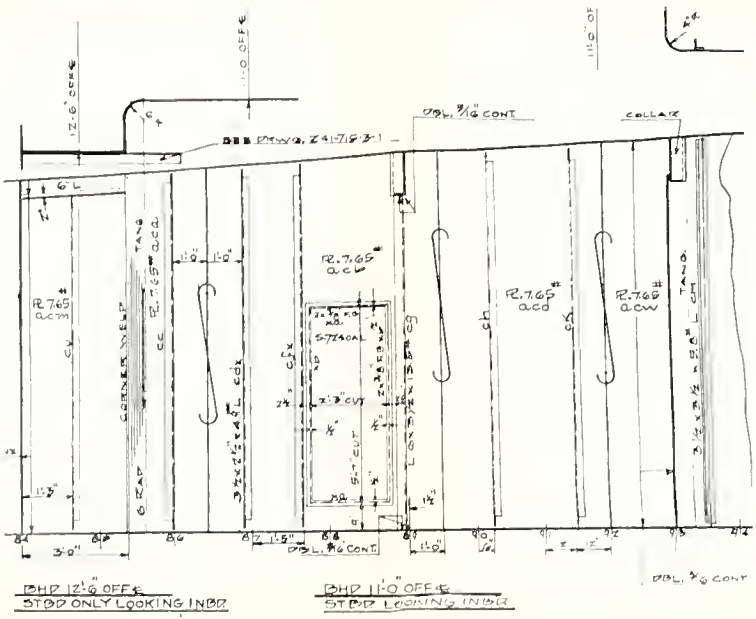
SHIP ERECTION FIG. 201

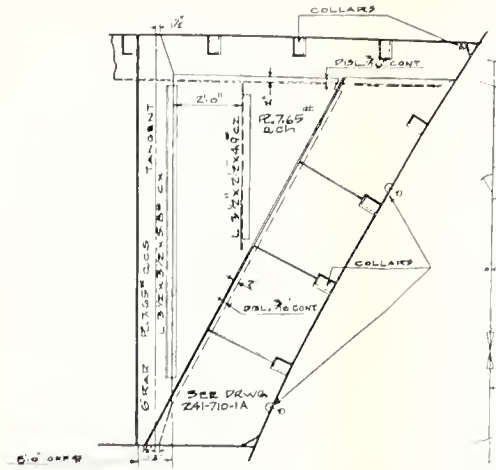
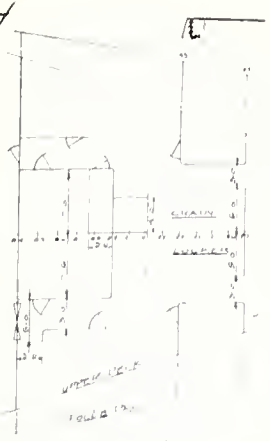


SHIP ERECTION FIG. 194



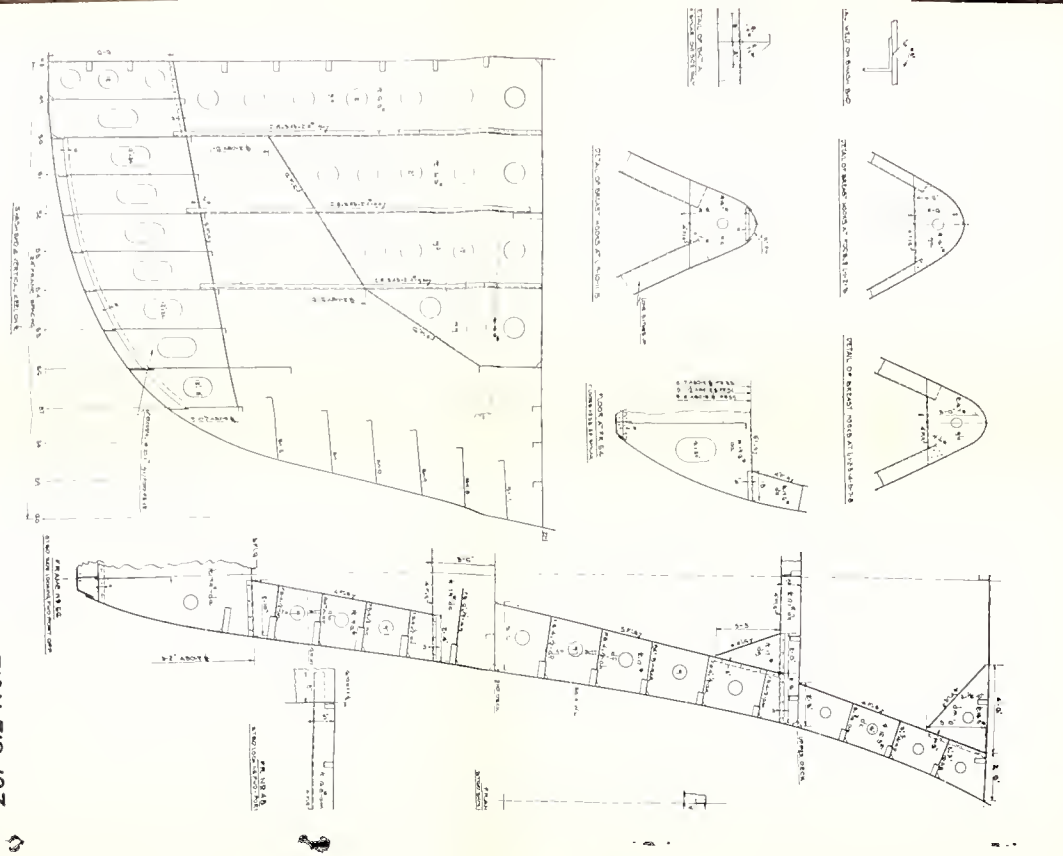
SHIP ERECTION FIG. 195



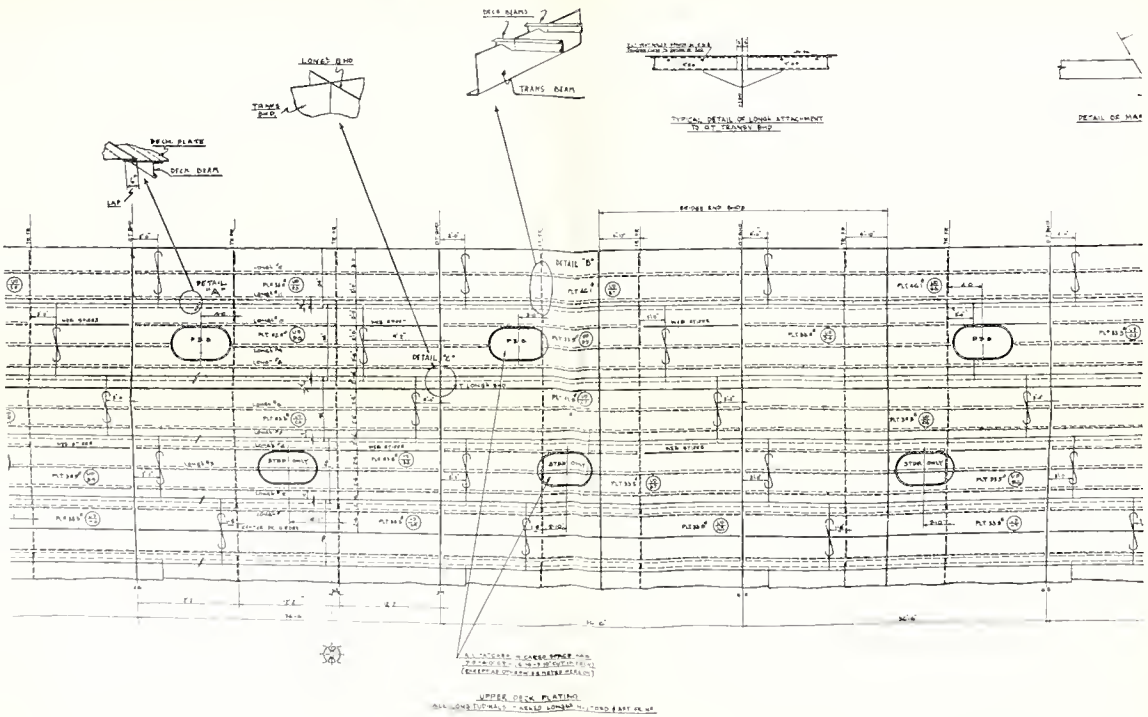


SHIP ERECTION FIG. 200

BHDS ON UPPER DECK-FORWARD-



SHIP ERECTION FIG. 197



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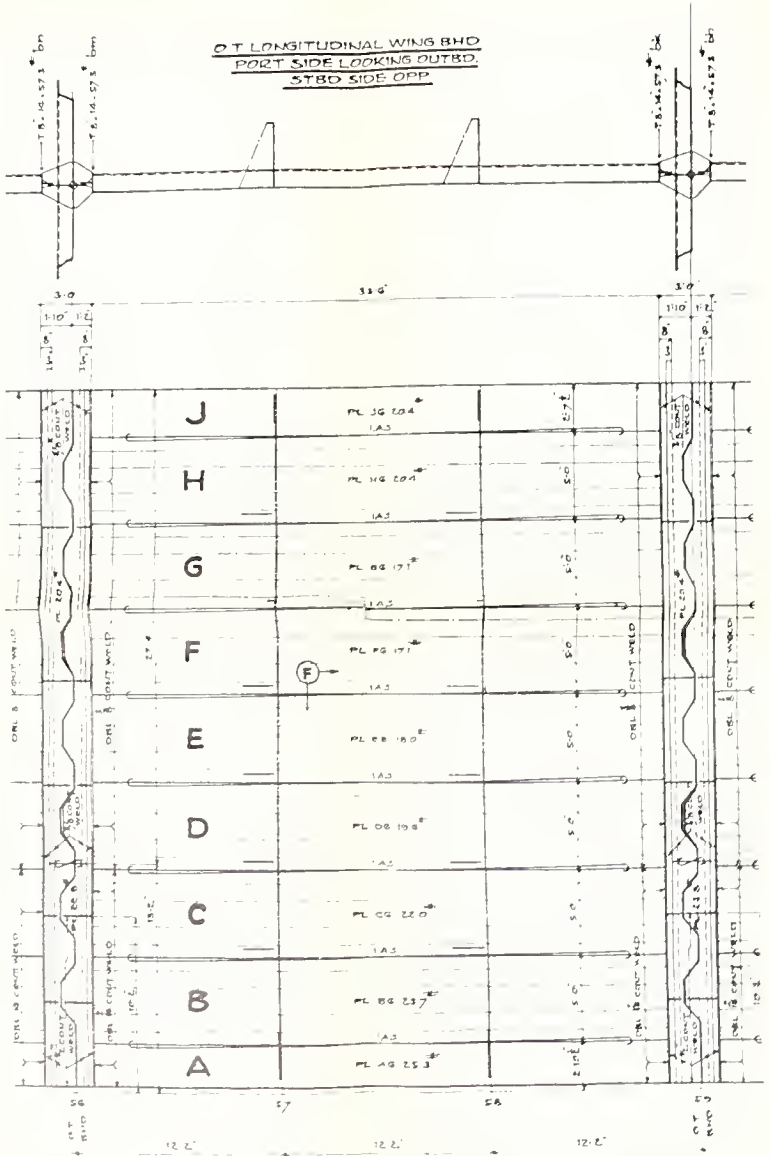
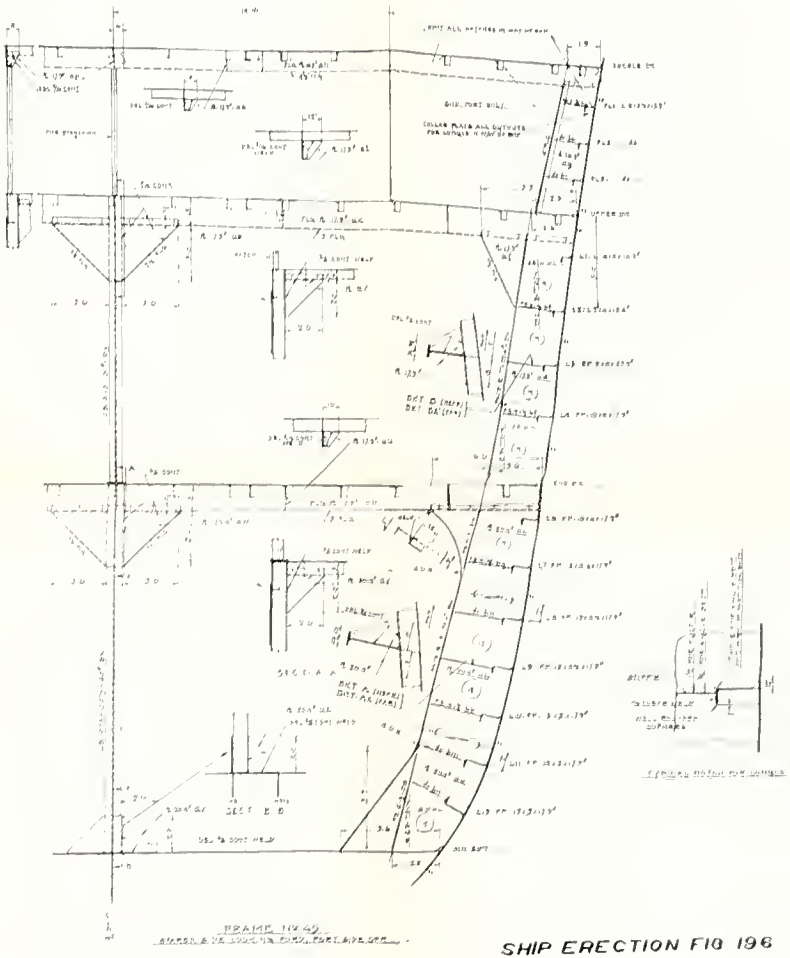
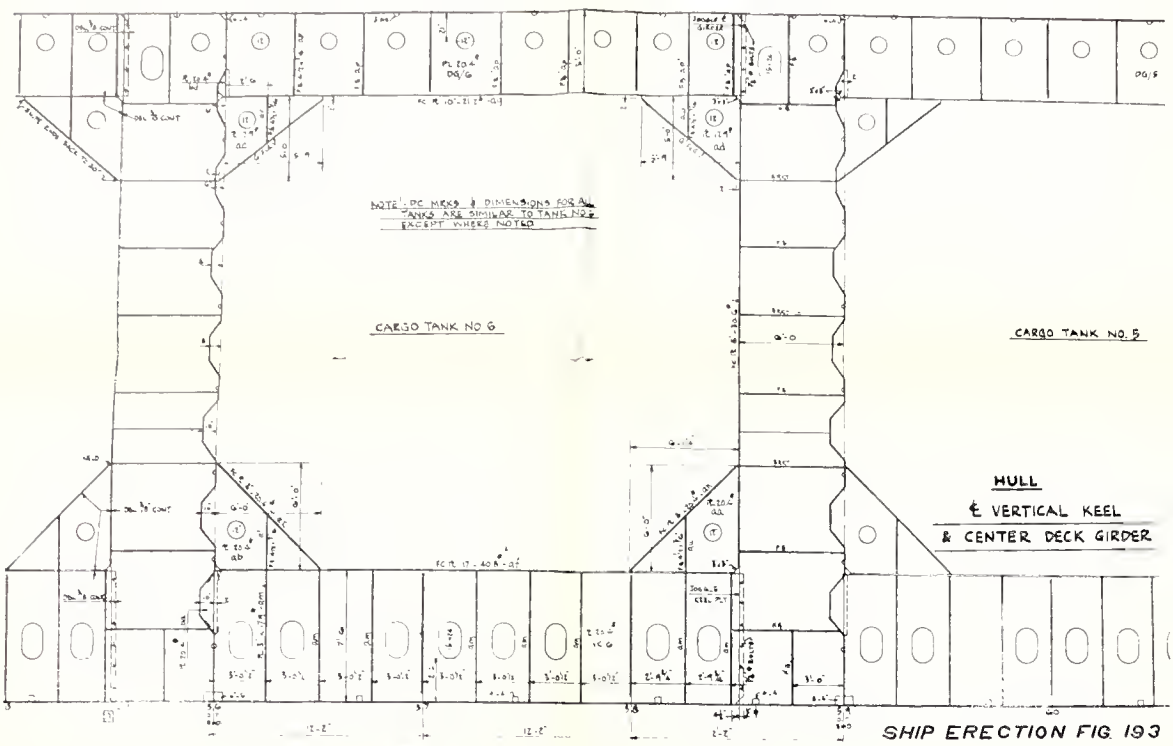


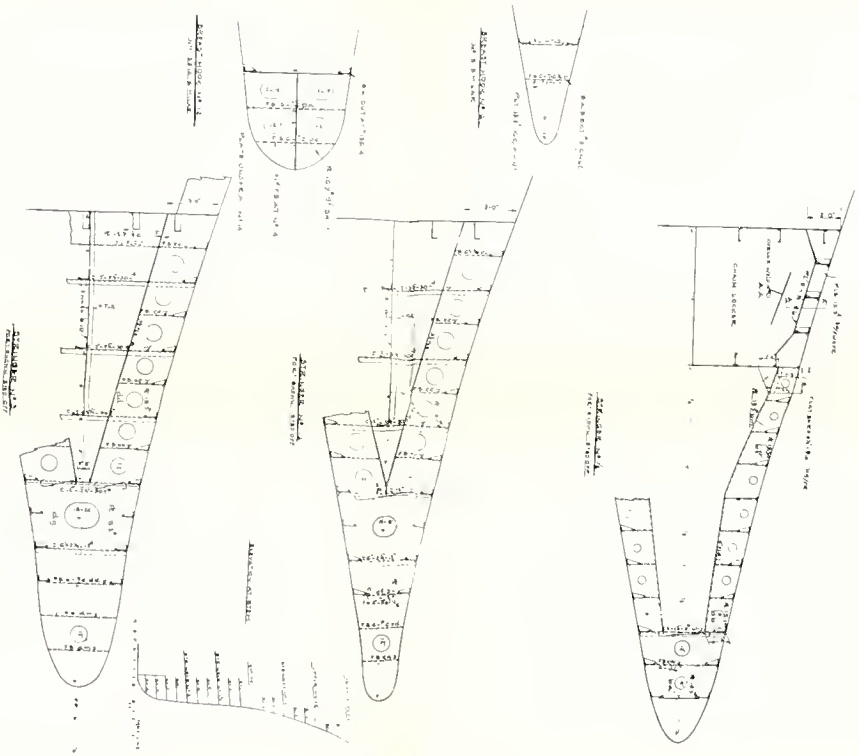
SHIP ERECTION FIG. 199



SHIP ERECTION FIG 196


NOTE: PC MKS & DIMENSIONS FOR ALL TANKS ARE SIMILAR TO TANK NO 2 EXCEPT WHERE NOTED
CARGO TANK NO 6
CARGO TANK NO. 5
HULL
℄ VERTICAL KEEL
& CENTER DECK GIRDER

SHIP ERECTION FIG 193



SHIP ERECTION FIG 202